

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

Studies on the Genus *Pluteus* I. Redescriptions of American Species Based on a Study of Type Specimens*

ALEXANDER H. SMITH and D. E. STUNTZ

For the last ten years we have been collecting data, both individually and together, on the North American species of *Pluteus* for the purpose of revising them. Material for microscopic study of the types of American species was obtained as long ago as 1936, but a preliminary survey of the problems involved in the study of this material clearly indicated to us that we needed more experience with fresh specimens to give us a clear view of speciation in the genus and a sufficient background to interpret properly the details observed in the course of studying the types. Since type specimens of agarics are destructible and irreplaceable we believe that all who study them have an obligation to the botanical public to publish the complete results of their studies, not just their conclusions. It is a well known fact that no investigator, past or present, ever has had or does have the omniscience to see and record all that is of value from a single study of a type. Hence in the following presentation we wish it clearly understood that we are presenting as complete a set of data on the microscopic characters of each species as we can obtain at this time and with present-day techniques. We are also presenting illustrations of these characters so that they may be more accurately judged than from word-pictures alone.

This is important because in the last fifteen years considerable has been written on *Pluteus*. The two most important treatments are one by Kühner and Romagnesi (1953) and one by Singer (1956). The latter work, especially, deals with many American species and may actually be given credit for stimulating us to present this paper at the present time.

The reason for this is that in many instances we found our observations on the type specimens to differ from those published by Singer. At the present time we cannot explain all the discrepancies. We

*Papers from the University of Michigan Herbarium and the Department of Botany, No. 1077, University of Michigan, Ann Arbor, Michigan, and The Department of Botany of the University of Washington, Seattle, Washington.

realize that Dr. Singer can measure spores and observe cystidia as accurately as we can. That, in spite of this, discrepancies exist is cause for concern and a review of the contributory causes is certainly in order.

When a type consists of a number of carpophores there is always the possibility of a mixed collection. One investigator might thus make observations on one element or taxon in the collection and the next investigator by studying the second element would find his observations at odds with those of the first one. It is clear to us that this is what has happened as concerns Dr. Singer's observations and ours on certain species. Our reasons for considering our interpretation as the correct one are given under the appropriate species.

A second cause for disagreement goes back to the original reason why we put off our study in the first place. Namely, after one has learned to know a hundred or more species of a genus in the field, knows what changes they undergo in drying and whether or not the dried material can be readily revived or revives only poorly at best, he can get much more information from a type than one starting out to study a genus in the "logical" manner by studying the types first. According to our experience the latter procedure is always wasteful of type material in the fleshy fungi. Singer (1956) in his study had the disadvantage of less experience with the genus in the field than we have had, and was the first to publish extensively on American types. In our study we have had the advantage of our extensive experience with the genus here in North America, as well as having Singer's observations as a basis for comparison. It is thus not surprising that we have added significant data on many species.

Yet some discrepancies between our observations and those of Singer remain to be explained. It is possible that in the years since 1936 as the result of specimens being loaned for study some interchange of specimens has accidentally occurred. We have no information indicating this but it is a possibility. At the time Smith was working with these types at the New York Botanical Garden they were still just as Murrill left them. Dr. Seaver, who was then curator, was very explicit in his instructions that only one type should be studied at a time in order that there be no chance of misplacing specimens in the wrong boxes. Dr. Seaver's instructions were carefully observed. Each small portion taken for microscopic study was placed in a small packet and labeled, and the type replaced in its box before the next box was opened. Because this procedure was followed, we believe that our interpretations of the types involved here are the correct ones, and for this reason we venture to redescribe and illustrate in detail the microscopic characters and give a redescription of the species based entirely and only on the original description and our data from the type specimen.

The details to be observed in a microscopic study of species of *Pluteus* have been fairly well covered by Singer (1936). However, we have paid careful attention to studying the spores both in profile and in face view, and noting whether the wall was so thin that the spore readily collapsed or not. This, we believe, is an important taxonomic character in certain species. Spore size and shape, as can be seen from

our drawings, is also distinctive for certain taxa. The warts or bumps found on the hyphae of the cuticle of the pileus have also been noted where present as these may turn out to be a character of some value in the genus as a whole.

In regard to the presence or absence of clamp connections, especially in species of the *Cellulodermi*, we do not believe that either Singer's or our own observations concerning the absence of clamps are at all conclusive when the observations are from such limited material as a type specimen. The situation as regards clamp connections on the fruiting bodies of *Plutei* is somewhat of an enigma in that clamps are often very rare. Only in the *P. cervinus* complex have we found it possible to put the character to any practical use and even there we still have some doubts.

The drawings are all made with the aid of a camera-lucida and as reproduced the spores are approximately $\times 1000$ and the cystidia $\times 450$.

We wish to acknowledge the kindness of Dr. Fred J. Seaver, then curator at the New York Botanical Gardens, for the courtesy of allowing Murrill's types to be studied and for his guidance and help in locating the specimens. The present paper deals almost entirely with Murrill's types as published in the *North American Flora*, Vol. 10.

PLUTEUS ATRIAVELLANEUS Murrill, *North Amer. Flora* **10**: 131. 1917.

Figs. 1-4. Spores, pleurocystidia and cheilocystidia.

Pileus 1-2 cm. broad, convex to expanded, not umbonate, regular, surface hygrophanous, finely pubescent to glabrous, not rugose, uniformly fuliginous when young, becoming avellaneous with age, margin entire, concolorous, striate.

Lamellae free, broad, ventricose, subcrowded, white to salmon-colored, entire and whitish on the edges.

Stipe 3 cm. long, 1-2 mm. thick, equal, slender, smooth, glabrous, pallid.

Spores $6.5-8(8.5) \times 5.5-6.5 \mu$, broadly ellipsoid, smooth, pale lilac in KOH (under high oil immersion), wall slightly thickened; basidia 4-spored; pleurocystidia abundant, $50-70(80) \times 10-18 \mu$, fusoid-ventricose to an obtuse apex which may be prolonged into a finger-like projection of irregular outline (undulating walls), thin-walled, readily collapsing, smooth or with a thin nearly hyaline amorphous incrustation (in KOH); cheilocystidia $30-45 \times 10-17 \mu$ and clavate, smooth and thin-walled, or like the pleurocystidia, both types hyaline; cuticular elements a turf of pilocystidia $60-200 \times 12-10 \mu$, subcylindric to fusoid, content dingy yellowish, no incrustations present; caulocystidia obventricose with rounded apices to clavate, $45-90 \times 14-22 \mu$, thin-walled, hyaline, no incrustations seen. Clamp connections none.

Habit, habitat and distribution. Solitary on humus in mixed woods, Unaka Springs, Tenn., August, 1904. Murrill 673.

Observations: Singer (1956) did not illustrate the pleurocystidia of the type and from his descriptions it is not clear that the collections he has placed here checked with the type in this important character. In addition his specimens came from wood, not humus. They need to be restudied. Singer also considered *P. compressipes* a synonym of *P. atriavellaneus* but the latter as we found it had thinner-walled spores.

Also, we found some clamp connections in *P. compressipes*. In view of these differences we believe the two are distinct.

PLUTEUS AURANTIACUS Murrill, North Am. Flora **10**: 129. 1917.

Figs. 5-8. Spores, pleurocystidia, cheilocystidia, and cells from cuticle of pileus.

Pileus 2 cm. broad, convex to umbonate, not expanding, regular, glabrous, rugose, deep orange yellow, striate, margin entire.

Lamellae free, rather broad, nearly crowded, *pallid* to salmon-colored, edges entire and concolorous.

Stipe 4-5 cm. long, 2 mm. thick, slender, fragile, equal, hollow, glabrous, shining, pale yellow.

Spores subglobose to broadly elliptic, $6-6.5 \times 5.5-6 \mu$, faintly lilac (under high power oil-immersion lens, viewed in KOH mounts), smooth, wall very slightly thickened; basidia 4-spored, $(15)17-22 \times 6-5-8 \mu$, clavate or slightly broader in midportion; pleurocystidia scattered, $28-38(50) \times 9-14 \times 5-10 \mu$, apices obtuse to rounded and as revived in KOH conspicuous because of a large cap of dried mucilage over neck and apex, otherwise thin-walled and hyaline; cheilocystidia similar to pleurocystidia or merely vesiculose-pedicellate, hyaline and thin-walled (revived in KOH); cuticle of pileus of clavate-pedicellate cells in a palisade, the cells $15-33 \mu$ in diam. in broadest part; clamp connections none.

Habit, habitat and distribution: On decayed wood, among mosses in swampy ground, West Park, N. Y. City. Aug. 1, 1903. Earle-1664. Type.

Observations: Singer (1956) considered this species to be the same as *P. aurantio-rugosus* which to him is an earlier name for *P. coccineus* and *P. calocephs*. We have studied a fungus which we identified as *P. coccineus* and found the spores to be $6.5-8 \times 5-6 \mu$ and the stipe to be orange. In Murrill's type the spores are smaller and the stipe is described as yellow. Hence we do not accept Singer's synonymy, and present our studies for future reference. We believe Murrill's type belongs in the *P. admirabilis* stirps, a closely related but distinct group based on color of the young caps.

PLUTEUS AVELLANEUS Murrill, North Amer. Flora **10**: 133. 1917.

Figs. 9-12. Pleurocystidia, cheilocystidia, cells of the cap cuticle, and spores.

Pileus 3.5 cm. broad, convex, not fully expanding, not umbonate, surface smooth, glabrous, hygrophanous, avellaneous, margin striate, concolorous and entire.

Lamellae free, broad, subventricose, crowded, white to salmon-colored, whitish-pruinose on the edges.

Stipe 5 cm. long, 4 mm. thick, equal, smooth, glabrous, white.

Spores $6-7(7.6) \times 5-5.5(6) \mu$, broadly ellipsoid, smooth, wall slightly thickened, pale lilaceous in KOH under high oil-immersion; basidia $28-35 \times 7-9 \mu$, 4-spored; pleurocystidia abundant, variable in shape: 1) clavate and $38-50 \times 15-22 \mu$; 2) fusoid-ventricose, $50-77 \times 13-20 \mu$, long-pedicellate at base, above ventricose part tapered to an acute to subacute apex or with 1-2 protuberances at

apex; 3) broadly fusoid-ventricose with broad but tapered neck to a broadly rounded apex; all types intergrade, walls thin, smooth, content hyaline to slightly yellowish revived in KOH; cheilocystidia smaller than pleurocystidia but similar otherwise; cuticular elements of elongate-cylindric to ventricose end-cells $15-30\ \mu$ in diam. and not truly cystidioid, walls thin, content colored to hyaline, apices *rounded* to obtuse; clamp connections none.

Habit, habitat and distribution: Gregarious on dead wood, Lake Placid, Adirondack Mts. N. Y., July 17-29, 1912. W. A. Murrill 91.

Observations: Singer (1956) reported numerous clamp connections and larger spores. It seems clear to us that the type is a mixture of more than one species. The presence or absence of clamps was an easy point to ascertain since the hyphae revived well and many cross walls were clearly seen.

PLUTEUS CALIFORNICUS McClatchie, Proc. So. Calif. Acad. **1**: 384. 1897.

Figs. 13-15. Pleurocystidia, cheilocystidia, spores, and cells from the cuticle of the pileus.

Pileus 2-4 cm. broad, convex to expanded, surface hygrophanous, rugose-veined, greenish-gray becoming cinnamon gray, margin thin, short-striate; flesh 2-3 mm. thick, odor and taste not recorded.

Lamellae crowded, thin, elliptic, 3-5 mm. broad, grayish white to flesh-gray.

Stipe 2-6 cm. long, 2-3 mm. thick, nearly straight, shining, pale yellowish-gray, hollow, fibrous.

Spores $7-8.8(10) \times 5.5-6.6\ \mu$, broadly ellipsoid to sub-globose, wall slightly thickened, smooth, lilac under high oil immersion (in KOH); basidia 4-spored, $30-37 \times 9-11\ \mu$, broadest just below apex, hyaline in KOH; pleurocystidia scattered, $45-60 \times 10-18\ \mu$, ventricose with broad necks and obtuse to rounded apices, smooth, thin-walled, hyaline in KOH; cheilocystidia $35-47 \times 9-16\ \mu$, clavate to elliptic, smooth, thin-walled, hyaline in KOH; cuticle a palisade of vesiculose-pedicellate to sessile cells up to $40\ \mu$ broad, content dark yellow-brown in KOH; clamp connections none.

Habit, habitat and distribution: On the ground among decayed leaves and branches, Pasadena, California.

Observations: The species is clearly a member of the *Cellulodermi* and apparently distinguished by the greenish gray cap when young.

PLUTEUS CAMPANULATUS Murrill, North Amer. Flora **10**: 131. 1917.

Fig. 17. Spores.

Pileus 3 cm. broad, obtusely campanulate, glabrous, pale pinkish fawn, margin striate to disc.

Lamellae free, crowded, narrow, watery white to pink.

Stipe 3-5 cm. long, 2-3 mm. thick, slightly tapering upward, glabrous, pallid or whitish, hollow, the base discoid and attached by a mat of mycelium.

Spores $6-6.6 \times 5-5.3\ \mu$, subglobose to ellipsoid, wall thin and a fair number remaining collapsed, lilaceous in KOH under high oil immersion; hymenium not reviving (some signs of vesiculose-pedicellate pleurocystidia evident but none revived well enough to study); cuticle

of pileus a palisade of pedicellate-vesiculose to elliptic cells with yellow-brown content in KOH; no clamps seen.

Habit, habitat and distribution. On rotten wood in wet woods, Redding, Connecticut, July 1902, Underwood & Earle 655.

Observations: The fruiting bodies have the stature of *P. admirabilis*. The hymenium of the type was almost completely destroyed by insect larvae as the specimens dried. The species is clearly a member of section *Celluloderma*.

PLUTEUS COMPRESSIPES Murrill, North Amer. Flora **10**: 137. 1917.

Figs. 16 and 18–20. Cells from cuticle of pileus, pleurocystidia, cheilocystidia, and spores.

Pileus 3–4 cm. broad and 1 cm. high (thick—Murrill), convex to subexpanded, not umbonate, surface glabrous, striate, rosy isabelline, somewhat darker on the disc, margin entire, concolorous.

Lamellae free, of medium distance, broad, white to salmon-colored.

Stipe 3 cm. long, 2–3 mm. thick, slender, tapering upward, compressed, smooth, glabrous, white, attached by a white mat of mycelium.

Spores $6-7 \times 5.5-6.5 \mu$, subglobose to broadly ellipsoid, smooth, *thin-walled* and *many remaining collapsed in mounts in KOH*, hyaline in KOH under high oil-immersion; basidia none with good sterigmata seen; pleurocystidia $50-77 \times 12-18 \mu$, fusoid-ventricose, apices obtuse to subacute, some with a slight constriction in the neck near the apex but no apical or subapical appendages present, thin-walled, smooth, hyaline; cheilocystidia $36-45 \times 10-17 \mu$, ventricose with broadly rounded apices to nearly clavate, thin-walled; cuticular elements elongate-clavate ($60-150 \times 14-22 \mu$) hyphal tips with brownish content in KOH, smooth and thin walled; clamp connections present (but hard to demonstrate).

Habit, habitat and distribution: Gregarious on dead wood in Castleton Gardens, Jamaica, Dec. 15, 1908, W. A. Murrill 118.

Observations: This species is a puzzle because certain characters given in the original description do not check with the type. Murrill described the type as glabrous but its cuticular elements are the kind that usually cause the cap to appear appressed fibrillose to minutely scurfy. Also the size of the cap is unusual for such a slender stipe. As pointed out by Singer (1956) the type specimens are much smaller than Murrill's published dimensions would indicate.

The most distinctive character of the type is the thin wall of the spores. Most spores in mounts revived in KOH remain at least partly collapsed. The pleurocystidia are fairly abundant. None was found having a finger-like projection near or at the apex. Clamp connections were clearly demonstrated on the type but they are rare and hence of doubtful taxonomic value.

The hymenium of the type is both poorly preserved and damaged by a parasite, but the characters as given in the description were all clearly demonstrated after much painstaking study. Singer reported clamp connections as absent, but in this instance we do not regard the apparent discrepancy as serious since we had to make a number of mounts to demonstrate a few clearly.

PLUTEUS EARLEI Murrill, Mycologia 3: 276. 1911.

Figs. 21 and 22. Spores, pleurocystidia, and cheilocystidia.

Pileus 10 cm. broad, rather thick, expanded, somewhat gibbous, surface dry, densely floccose, uniformly pale yellow, margin even, not striate.

Lamellae free, crowded, broad, becoming dull pinkish.

Stipe 8 cm. long, 1 cm. thick, slightly tapering upward, solid, white, glabrous.

Spores $7-8.8 \times 6-6.5(7) \mu$, ellipsoid to broadly ellipsoid, wall rather thick ($\approx 0.9 \mu$), dingy yellowish in KOH under high oil-immersion; basidia 4-spored; pleurocystidia $33-47(56) \times 10-16 \mu$, fusoid-ventricose, apices subacute, smooth, thin-walled, yellowish-hyaline in KOH, not incrustated; cheilocystidia very few, those found were like the pleurocystidia; cuticle of radial hyphae with end-cells relatively undifferentiated, their apices obtuse; hyphae of context $9-13 \mu$ in diam, hyaline-refractive, interwoven and not collapsing (like those of *P. griseobrunneus*); clamp connections, none found.

Habit, habitat and distribution: On a log, Guanajay, Cuba, Sept. 14, 1904. Earle 1525.

Observations: The organization of the gill trama and the context of the pileus is that of *P. griseobrunneus*, but the similarity between the two ends there except for the thick-walled spores. *P. earlei* is a very distinctive species. The cuticle of the cap in the type is badly parasitized with the hyphae of an imperfect fungus.

PLUTEUS FIBRILLOSUS Murrill, North Amer. Flora 10: 134. 1917.

Figs. 25-26. Pleurocystidia and spores.

Pileus 3 cm. broad, convex to expanded, not umbonate, surface moist, faintly striate, uniformly dark fuscous, pale fuliginous faded, minutely innate-fibrillose, margin entire to undulate or slightly lobed, thin but rather firm.

Lamellae free, rather broad, ventricose, crowded, white to salmon-colored, entire and concolorous on the edges.

Stipe 7 cm. long, 4-6 mm. thick, tapering upward, solid, smooth, glabrous, white.

Spores $5.8-7 \times 5.5-6.8 \mu$ subglobose to globose, smooth, pale lilaceous in KOH under high oil immersion, wall slightly thickened, many appearing globose in mounts of revived material; basidia 4-spored, $20-27 \times 7-8 \mu$; pleurocystidia $(40)60-88 \times 15-20 \mu \times 7-10 \mu$, fusoid-ventricose with obtuse apices, thin-walled and readily collapsing, hyaline in KOH, smooth (after wrinkles are taken out); cheilocystidia $(35)45-60(80) \times 10-16(20) \mu$, fusoid-ventricose with obtuse apices or some nearly cylindric, hyaline, thin-walled, smooth or with dried mucilaginous material over apex; cuticle of pileus a turf of elongate hyphal end-cells, $(40)80-130 \times 10-20 \mu$, elongate-clavate to obscurely fusoid-ventricose in upper third and apex obtuse, content dingy yellow-brown in KOH, apices often with incrustated amorphous particles or irregular patches of material; clamp connections, none.

Habit, habitat and distribution: Solitary on soil in a wet thicket, Chalmette, New Orleans, La., Sept. 8, 1908. Earle 129.

Observations: Singer (1956) did not record incrustations over

the upper part of the cuticular elements and we saw no pleurocystidia or cheilocystidia with colored content. His statement that very few spores are globose is misleading. It is very unusual for a *Pluteus* to have the cuticular elements incrustated as they are in this species. We consider it likely that this will turn out to be an important character.

PLUTEUS FULIGINOSUS Murrill, North Amer. Flora **10**: 134. 1917.

Figs. 27-29. Pleurocystidia, cheilocystidia, and spores.

Pileus 3-4 cm. broad, conic to campanulate, not expanding, umbonate, regular, surface smooth, uniformly fuliginous, clothed with white hairs, margin concolorous, entire, striate.

Lamellae free, ventricose, crowded, white to salmon-colored, entire and concolorous on the edges.

Stipe 6 cm. long, 4-7 mm. thick, tapering upward, smooth, glabrous, white or pale yellowish, slightly squamulose and tinged with pale-avellaneous near the base.

Spores $6.5-7.5 \times 5-6 \mu$, broadly ellipsoid to subglobose, smooth, wall yellowish-pallid in KOH and content pale lilaceous in KOH under high oil-immersion; basidia $33-44 \times 6.5-8 \mu$, long for the genus, clavate when young, broadest just back of apex when sporulating; pleurocystidia scattered, $38-55(77) \times 10-15(19) \mu$, fusoid ventricose, some with 1-3 subapical to apical small protuberances, hyaline, thin-walled, smooth; cheilocystidia abundant (gill edge sterile), $35-50 \times 12-18(20) \mu$, broadly fusoid-ventricose, with acute to subacute apices, at times furnished with 1-2 small protuberances of the wall, hyaline, thin-walled, readily collapsing; cuticular elements of terminal cells often in fascicles and cells elongate-fusoid, $100-220 \times 10-20 \mu$, content hyaline to light brownish in KOH; clamp connections absent for all practical purposes (1 seen after an hour's search).

Habit, habitat and distribution: solitary on white pine stump, Lake Placid, Adirondack Mts., N. Y., July 17-29, 1912. W. A. Murrill 118.

Observations: Singer (1956) stated of the cheilocystidia "shape of *Cervinus* metuloids, but not thick-walled and not pronged." All the pleurocystidia we observed were of the type illustrated and these are certainly not what Singer described. Singer did not mention the length of the basidia as a character, but we believe it has some value in this species—a rather rare situation in *Pluteus*. We found one recognizable clamp connection as the result of an hour's search, which in itself may not mean much, but it does establish their presence. When the difficulty of establishing this character on dried material, such as type specimens, is considered, however, our observation may have considerable significance, for it may be that in the study of fresh material clamps can be rather readily demonstrated. Consequently we hesitate to recognize as authentic the identification by Singer of specimens which he placed here but which were collected on other substrata, and presumably lacked clamps.

PLUTEUS FULVIBADIUS Murrill, North Amer. Flora **10**: 136. 1917.

Figs. 30-32. Spores, pleurocystidia, and cheilocystidia.

Pileus 5 cm. broad, 3 cm. high, conic to campanulate, not fully expanding and remaining umbonate, surface glabrous, hygrophanous,

fulvous-badious, castaneous on umbo, distinctly rugose-radiate or reticulate-rugose, margin concolorous and splitting in age, not striate.

Lamellae free but approximate to stipe, crowded, ventricose, not very broad, citrinous to salmon-colored, entire and white on the edges.

Stipe about 9 cm. long and 1 cm. thick, subequal, fleshy, hollow, glabrous, citrinous, longitudinally striate.

Spores $5.5-7 \times 5-6 \mu$, broadly ellipsoid to subglobose, smooth, pale lilac in KOH under high oil-immersion, wall slightly thickened; basidia 4-spored, $17-20 \times 7-8 \mu$; pleurocystidia scattered to abundant, $38-60 \times 15-30 \mu$, clavate-pedicellate to obventricose with slightly narrowed neck and broadly rounded apex, thin-walled and readily collapsing; hyaline in KOH, some with amorphous material adhering irregularly to surface; cheilocystidia similar to pleurocystidia but smaller; cuticle of pileus a well-formed palisade of pedicellate-clavate cells and fusoid-ventricose cells with their content cinnamon to dark cinnamon in KOH (pigment dissolved in cell sap, not in the form of discrete bodies); clamp connections, none.

Habit, habitat and distribution: Type collected on the ground in woods at Glen Brook, Oregon, Nov. 7, 1911, W. A. Murrill 760.

Observations: The brown pigment bodies described by Singer (1956) were not present in any of our sections, but a dissolved pigment was strikingly evident. We used KOH as a mounting medium. We found a similar species with clamp connections in Washington.

PLUTEUS GLABRESCENS Murrill, North Amer. Flora **10**: 130. 1917.

Figs. 33-37. Pleurocystidia, cuticular elements, cheilocystidia, and spores.

Pileus 2 cm. broad, convex, surface subviscid, glabrous, shining, yellowish-brown, becoming dark-brown on drying.

Lamellae free, crowded, subventricose, pale pink.

Stipe 7 cm. long, 4 mm. thick, cylindric, glabrous, white with a flesh-colored tint, hollow.

Spores $6-7(7.5) \times 5-6 \mu$, broadly ellipsoid to subglobose, lilac in KOH under high oil-immersion, wall slightly thickened, smooth; basidia 4-spored, $20-26 \times 6-7 \mu$, ventricose above the middle when sporulating, pleurocystidia abundant, fusoid-ventricose, with obtuse to acute apices, some with short apical protuberances, $50-65 \times 12-19 \mu$, thin-walled, smooth, hyaline in KOH; cheilocystidia $28-42 \times 9-17 \mu$, ventricose with sharply tapered necks and acute apices, smooth, thin-walled, hyaline in KOH; cuticular elements of elongate-fusoid cells with yellowish to hyaline content, thin smooth walls and acute apices, $12-25 \mu$ in diam.; no clamps found.

Habit, habitat and distribution: On rotten wood, West Park, New York, August 1903, Earle 1740.

Observations: It is obvious that the specimen which is now labeled the type was never subviscid and shining, as called for in the original description. Caps with the cuticular elements of the kind described above appear fibrillose to subgranulose. However, all we can do here is note the possible discrepancy. The specimen we studied certainly is the same one Singer studied. The cheilocystidia with their acute apices are here considered as being a distinctive character.

PLUTEUS DELIQUESCENTS Murrill, North Amer. Flora **10**: 134. 1917.

Figs. 38-40. Pleurocystidia, cheilocystidia, and spores.

Pileus 3.5 cm. broad, broadly campanulate, surface hygrophanous, glabrous, brownish, margin striate; context soft, watery, very fragile, deliquescent.

Lamellae free, broad, pallid or subconcolorous, watery.

Stipe 5 cm. long, 2-3 mm. thick, cylindric, glabrous, pallid, hollow, firm.

Spores $5.5-6.5 \times 5-5.8 \mu$, globose to subglobose, thin-walled and many remaining collapsed in mounts in KOH, pale lilac in KOH under high oil-immersion; basidia 4-spored; $28-35 \times 8-9 \mu$, ventricose in mid-portion when sporulating; pleurocystidia fusoid-ventricose, $35-47 (56) \times 9-15 \mu$, neck often wavy (as revived), apex obtuse to capitate, hyaline, thin-walled, smooth; cheilocystidia clavate or like the pleurocystidia, if clavate $27-38 \times 9-12 \mu$ (not many seen); cuticle of appressed hyphae the end cells of which have obtuse to rounded apices, $8-12 \mu$ thick, dissolved pigment present in hyphae; clamps, none seen.

Habit, habitat and distribution: On rotten wood in a swamp, New Orleans, La., Sept. 5, 1908. Earle 53.

Observations: The pleurocystidia revived well and were clearly seen, but only a few cheilocystidia could be demonstrated. The hymenium, though poorly revived, gives the impression of the *Coprinus*-type, i.e., with pseudoparaphyses between the basidia. However these structures refused to revive. Convergent gill trama could not be demonstrated but the spores are certainly typical of *Pluteus*. Singer also recognized that it was a *Pluteus* but considered its position uncertain. In our classification it would fall in section Hispidoderma. The fact that we found no clamp connections is not to be regarded as conclusive.

PLUTEUS GRISEIBRUNNEUS Murrill, North Amer. Flora **10**: 133. 1917.

Figs. 42-44. Pleurocystidia, cheilocystidia, and spores.

Pileus 4-5 cm. broad, conic-campanulate, strongly umbonate in dried specimens, surface dry, grayish brown, darker on disc, somewhat rimose but not striate, fibrillose; rather thin and fragile.

Lamellae free, broad, ventricose, crowded, white to salmon-colored, entire and concolorous on the edges.

Stipe 6 cm. long, 5 mm. thick, cylindric, equal, whitish, solid, minutely pubescent.

Spores $6-7 \times 4-4.5 \mu$, ellipsoid, smooth, pinkish in KOH (under high dry lens) hence well pigmented for a *Pluteus*, wall *relatively thick* and spores in mass under microscope dingy ochraceous, *not* lilac under high oil-immersion lens; basidia $\approx 22 \times 6.3 \mu$, 4-spored (one seen); pleurocystidia present but not reviving (those drawn were not actually seen in position on the gills but instead were free in crushed mounts); cheilocystidia definitely established, $46-57 \times 14-20 \mu$, fusoid-ventricose, smooth, hyaline, thin-walled; cuticular elements of pileus of filamentous hyphae, the end-cells \approx appressed to surface and $9-13 \mu$ in diam., equal throughout and apices rounded to obtuse (not in the least cystidioid), content melleous in KOH, thin-walled, smooth; context of a large number of equal, broad ($8-12 \mu$) interwoven, hyaline, refractive, non-collapsing hyphae with very few cross walls, some normal

inflated hyphae also present but these remaining collapsed, clamp connections none on the well-revived hyphae.

Habit, habitat and distribution: Solitary on dead wood, City Park, New Orleans, La., Sept. 6, 1908, Earle 71.

Observations: The species is peculiar in its spore characters. The pigmentation is more pronounced than usual but certainly pinkish under the high-dry objective on individual spores. In mass under the microscope the spores give a dull melleous effect apparently due to the wall color. The color is not that of members of the ochraceous-spored agarics such as *Galerina*, etc. The refractive hyphae of the context revive to such an extent as to bring the thickness of the context back to about its normal size. The effect of this is to cause one to question the statement in the description that the cap is thin and fragile, but we should like to point out that we do not assume that Earle's notes were incorrect on this point; rather, it appears to us that these rigid hyphae may be the cause of the fragility mentioned since they are not actually thick-walled, tough elements.

These hyphae also extend into the gill trama and in revived sections cause the latter apparently to have "interwoven" trama. We believe this to be an artifact caused by the divergent elements remaining collapsed. The type specimen was obviously old from the standpoint of the development and collapse of the hymenium, but probably appeared to be in good condition to the collector because of the unusual development of the refractive hyphae.

PLUTEUS JAMAICENSIS Murrill, *Mycologia* **3**: 278. 1911.

Figs. 41 and 45-46. Cheilocystidia, spores, and pleurocystidia.

Pileus 2-3 cm. broad, obtuse becoming expanded, surface dark-brown, paler with age, rugose, crustose-areolate, not striate; thin.

Lamellae free, subcrowded, broad, ventricose, white to pink.

Stipe 2 cm. long, 2 mm. thick, solid, white, enlarged above and below, glabrous except at the base which is conspicuously whitish tomentose.

Spores $5-6 \times 5-5.5 \mu$, subglobose, smooth, wall slightly thickened, color in KOH under high oil-immersion pale lilaceous; basidia not revived well; pleurocystidia scattered $50-70 \times 15-25$, clavate to ventricose with rounded apices, smooth, thin-walled, hyaline to yellowish in KOH, no incrustations seen; cheilocystidia similar to pleurocystidia; cuticular elements clavate-pedicellate in a loose palisade or in patches, content brownish as dissolved pigment; clamp connections not demonstrated (material poorly revived).

Habit, habitat and distribution: Subcespitose on rotten wood, Castleton Gardens, Jamaica, Oct. 28, 1902, Earle 220.

Observations: We did not find cheilocystidia of the type Singer (1956) described, but those described above were well demonstrated on both the faces and edges of the gills. The South American collections Singer referred here need to be checked for pleurocystidia.

PLUTEUS LATIFOLIUS Murrill, *North Amer. Flora* **10**: 135. 1917.

Figs. 47-49. Spores, pleurocystidia and cheilocystidia.

Pileus 4 cm. broad, convex to nearly plane, regular, not umbonate, surface dry, tomentose, smooth, avellaneous-isabelline, the disc radiate-

rugose with fuliginous lines, margin entire, concolorous, not projecting beyond the gills.

Lamellae free, very broad and ventricose, crowded, fragile, whitish to salmon-colored.

Stipe 5 cm. long, 5 mm. thick, equal, rather slender, firm, hollow, densely short-tomentose, concolorous.

Spores $5-6(6.5) \times 4.7-5.5 \mu$, broadly ellipsoid to subglobose, smooth, wall slightly thickened, color in KOH under high oil-immersion hyaline becoming pale lilaceous; basidia 4-spored; pleurocystidia $42-57 \times 12-18 \mu$, scattered to abundant, broadly fusoid-ventricose with obtuse apices and usually one short finger-like projection arising at or near the apex, thin-walled, smooth, readily collapsing, no incrustations seen, hyaline in KOH or only the wall dingy yellowish; cheilocystidia $34-45 \times 10-16 \mu$, more variable in shape than the pleurocystidia (from nearly clavate to subcylindric) and some furnished with an appendage; cuticular elements $100-200 \times 12-22 \mu$, narrowly subfusoid, content faintly brownish when first revived in KOH, becoming hyaline, smooth, thin-walled, "fibrils of the base of the stipe consisting of chains of hyphae with cystidioid terminal members, the latter e.g. $92-155 \times 15-24 \mu$, ventricose at base and attenuate upwards to an acute or more frequently obtuse tip, sometimes subcapitate at apex, with a dissolved pale brown sap in many cells, more rarely hyaline, with thick wall ($1-2 \mu$)" (Singer p. 171, 1956); clamps, none.

Habit, habitat and distribution: Solitary on dead alder, Seattle, Wash., Oct., Nov. 1911, W. A. Murrill 510.

Observations: This species should be easily recognized. Since Singer did not specifically mention the metuloid-like cystidia on the hyphae at the base of the stipe as being present in his Michigan collection, we do not admit the latter to the species. It is clear from our study of the type that *P. latifolius* has pleurocystidia which characteristically have an apical to subapical appendage. Again, this character appears to have been absent in Singer's Michigan collection.

PLUTEUS LEPIOTIFORMIS Murrill, North Amer. Flora **10**: 129. 1917.

Figs. 50-51. Spores and both pleuro- and cheilocystidia.

Pileus 1-2 cm. broad, small, convex, not fully expanding, not umbonate, much resembling in dried condition certain small species of *Lepiota*; surface not striate (it was rimose in the type as dried -AHS), pale-isabelline, with black strigose, appressed hairs which are more abundant on the disc, margin pallid, often lacerate with age.

Lamellae free, subcrowded, rather broad, white to pale salmon-colored, fragile, entire and concolorous on the edges.

Stipe 3 cm. long, 1 mm. thick, very slender, equal, smooth, glabrous, white.

Spores $4.7-6.5 \times 4.5-6.5 \mu$, essentially globose, smooth, relatively thin-walled (some remain collapsed), pale lilac in KOH under high oil-immersion; basidia 4-spored; pleurocystidia and cheilocystidia similar, $46-80 \times 14-18 \mu$, clavate-pedicellate to subventricose, with rounded apices or subcylindric, brownish from a dissolved pigment to hyaline, not incrustated, thin-walled; cuticular elements to some extent

similar to the cystidia (broad hyphal end-cells rounded to slightly attenuated at apex and narrowed at the base, content brownish); clamps, none found.

Habit, habitat and distribution: Solitary on the ground in a wet woods. City Park, New Orleans, La., Sept. 6, 1908. Earle 74.

Observations: The cystidia are an outstanding character along with the *Lepiota*-like aspect. With careful treatment we were able to revive the cystidia to their original form. It is clear to us that this species will show colored gill margins when again studied in the fresh condition, as this is always true when a large number of the cheilocystidia have colored contents. Singer suggests synonymy with *P. hispidulus* and *P. nitens*, a disposition we cannot accept in view of our findings, but attention is called to the unnamed form with bordered gill-edges which puzzled Singer and which he briefly described. However, the cheilocystidia were reported by Singer to be hyaline in KOH. Singer himself was obviously puzzled by this seeming contradiction in the character of his collection. On the basis of the information available we are not inclined to classify his collection (T-2137) as identical with *P. lepiotiformis* and consider the latter to be a species in good standing.

PLUTEUS LONGIPES Murrill, North Amer. Flora **10**: 133. 1917.

Figs. 52-54. Pleurocystidia, spores, and cheilocystidia.

Pileus 4 cm. broad, expanded, obtuse, surface dry, glabrous, pale ochraceous brown, margin striate.

Lamellae free, subcrowded, subventricose, pallid to brownish pink.

Stipe 11 cm. long, 4 mm. thick, very long and slender, cylindric, glabrous, shining, white, hollow.

Spores $5-6.5 \times 4.7-5.5 \mu$, subglobose to broadly ellipsoid, smooth, wall slightly thickened, content pale lilaceous in KOH (under highest oil-immersion); basidia 4-spored, $23-33 \times 6.5-8 \mu$; pleurocystidia $50-77 \times 10-18 \mu$, fusoid-ventricose with subacute to obtuse apices often furnished with 1-5 irregular protuberances or proliferations, hyaline, thin-walled, some showing a thin irregular incrustation as revived in KOH; cheilocystidia $33-44 \times 9-14 \mu$, fusoid-ventricose, hyaline, thin-walled, smooth, apices subacute, often somewhat irregular in upper part of neck as if beginning to proliferate; cuticular elements (only a few seen) broadly fusoid, $60-150 \times 12-25 \mu$, hyaline to yellowish within; clamp connections none.

Habit, habitat and distribution: On rotten trash in soil at Redding, Conn., July 22, 1902. F. S. Earle 628.

Observations: This species is in the section *Hispidoderma* and appears to be related to *P. flavofuliginens* though differing in the shining white stipe and nearly ochraceous-brown pileus.

PLUTEUS LUDOVICIANUS Murrill, North Amer. Flora **10**: 133. 1917.

Figs. 55-59. Cheilocystidia, pleurocystidia, cuticular elements, and spores.

Pileus 5 cm. broad, rather firm, convex to expanded, somewhat plicate-striate over marginal area (evident on dried specimens-AS), surface glabrous, hygrophanous, dark tan but in dried specimens pale fuliginous, margin paler.

Lamellae free, broad, crowded, white to salmon-colored, entire and concolorous on the edges.

Stipe tapering upward from a sub-bulbous base, 7 cm. long, 5-8 mm. thick, smooth, glabrous, shining, pallid or pale brownish, hollow.

Spores $6-6.5 \times 5-5.6 \mu$, broadly ellipsoid to subglobose, wall slightly thickened, smooth, lilaceous in KOH under high oil-immersion; basidia 4-spored, $23-27 \times 6-7 \mu$, clavate, becoming subcylindric when sporulating; pleurocystidia abundant, $45-60 \times 18-24 \mu$, pedicellate-subventricose, then slightly narrowed but enlarged again at the broadly rounded apex, at times merely broadly clavate, apex at first incrustated with a cap of dried mucilaginous material, thin-walled, readily collapsing, hyaline or only slightly yellowish from coagulated contents (no sign of a dissolved pigment); cheilocystidia vesiculose varying to similar to pleurocystidia but only $31-44 \times 16-26 \mu$, some smooth; cuticle a palisade of inflated-pedicellate cells with distinct yellow-brown pigment dissolved in cell sap; clamp connections, none.

Habit, habitat and distribution: Solitary on soil in a wet thicket, Chalmette, New Orleans, La., Sept. 8, 1908. Earle 130.

Observations: The plicate-striate margin is very distinct in the type, and the pleurocystidia are an additional distinctive character. Good connective hyphae with distinct cross-walls were demonstrated but no clamps were present so it seems likely that the observation of clamp-connections absent is meaningful in this instance. The plicate-striate cap may indicate a relationship with *P. longistriatus* but we are not convinced of this. We are more inclined to agree with Singer that it is a large species of the *P. nanus* complex.

PLUTEUS MELLEIPES Murrill, North Amer. Flora **10**: 129. 1917.

Figs. 60-62. Spores, pleurocystidia, and cheilocystidia.

Pileus 1-2.5 cm. broad, obtuse to broadly convex to expanded, surface glabrous, rugose, hygrophanous, cinnamon when moist, ochraceous when faded, margin not striate.

Lamellae free, crowded, ventricose, whitish to brownish pink.

Stipe 2-4 cm. long, 2 mm. thick, cylindric, glabrous, honey yellow.

Spores $6-7 \times 5-6 \mu$, broadly ellipsoid to subglobose, smooth, wall slightly thickened and pale yellowish to hyaline in KOH (no lilac showing under high oil-immersion); basidia $27-33 \times 8-9 \mu$, 4-spored; pleurocystidia abundant, $40-55 \times 10-18 \mu$, fusoid ventricose with tapered necks and obtuse apices, often with a cap of amorphous (mucilaginous?) material as revived in KOH, thin-walled, hyaline or nearly so and readily collapsing; cheilocystidia similar to pleurocystidia but smaller and not incrustated, $23-35 \times 7-12 \mu$; pileus cuticle a palisade of inflated-pedicellate cells (revived poorly and no colored content seen); clamp connections none but false clamps and clamp-like bumps seen, the latter not at cross walls.

Habit, habitat and distribution: On rotten wood at West Park, New York, July 30, 1903. Earle 1589. New York and Connecticut.

Observations: The aspect is that of a small *P. chrysophaeus*, but data on odor and taste are lacking. The fungus we refer to *P. chrysophaeus* has a pallid grayish, longitudinally fibrous-striate stipe and a farinaceous disagreeable odor and taste. In view of our present data

on North American *Plutei* we would not think of placing a *Pluteus* with a honey yellow stipe in synonymy with our *P. chrysophaeus*. Kühner and Romagnesi (1953) however, leave the door open for this interpretation by describing the stipe of *chrysophaeus* as sometimes yellowish at the base.

PLUTEUS MELLEUS Murrill, North Amer. Flora **10**: 129. 1917.

Figs. 63–65. Spores, pleurocystidia, and cheilocystidia.

Pileus 1–2 cm. broad, rather small, convex to subexpanded, umbonate, surface glabrous, rugose, pale melleous, slightly darker on the umbo, margin entire to undulate, concolorous.

Lamellae free, broad, ventricose, crowded, several times inserted, white to salmon-colored, entire and concolorous on the edges.

Stipe 2 cm. long, 1 mm. thick, very slender, cylindric, equal, smooth, glabrous, pale melleous.

Spores $5.7\text{--}6.5 \times 4.7\text{--}5.5 \mu$, broadly ellipsoid to subglobose, smooth, wall slightly thickened, content lilaceous in KOH under high oil-immersion; basidia 4-spored; pleurocystidia scattered, $50\text{--}80 \times 14\text{--}22 \mu$, ventricose-pedicellate with a tapered neck to an obtuse apex, typically capped with a mucilaginous cap of hyaline material, thin-walled, hyaline; cheilocystidia similar to pleurocystidia but smaller; cuticle of vesiculose-pedicellate cells in an even palisade, hyaline, $15\text{--}22 \mu$ in diam.; clamp connections, none seen.

Habit, habitat and distribution: Solitary on decayed wood, Unaka Springs, Tenn., Aug. 18–24, 1904, W. A. Murrill 840.

Observations: The species is clearly closely related to *P. chrysophlebius* (the *P. admirabilis* complex). It could easily be a synonym of *P. admirabilis* but the pale yellow color of the cap and stipe and white gills when young cause some doubts. These doubts are strengthened by the number of color variants which we have found in North America in this group but not yet identified.

PLUTEUS MULTISTRIATUS Murrill, Mycologia **3**: 277. 1911.

Figs. 66–69. Pleurocystidia, cheilocystidia, and spores.

Pileus 3 cm. broad, convex, depressed about the umbo, surface fuliginous, subglabrous, with numerous shallow furrows or striations extending from the umbo to the margin.

Lamellae free, close, broad, pallid.

Stipe 4 cm. long, 2–3 mm. thick, slender, equal, glabrous, white.

Spores $5.4\text{--}6.5 \times 4.7\text{--}5.5 \mu$, broadly ellipsoid, smooth, wall thickened, content lilac in KOH (under high oil-immersion); basidia 4-spored; pleurocystidia of 2 types: 1) large, ventricose-pedicellate, with only slightly tapered necks and broadly rounded apices, $70\text{--}120 \times 15\text{--}33 \mu$, content yellowish brown, apex at times with a short narrow protuberance; 2) $40\text{--}70 \times 9\text{--}12 \mu$, narrowly ventricose with long narrowed neck $7\text{--}10 \mu$ thick, content brownish; cheilocystidia $34\text{--}47 \times 9\text{--}16 \mu$, hyaline, fusoid-ventricose, smooth, no incrustations; elements of cuticle of elongate hyphae, the end cells somewhat fusoid (not strongly ventricose); clamp connections none.

Habit, habitat and distribution. Subcespitose on a railroad tie, Jalapa, Vera Cruz, Mexico, Dec. 12–20, 1909, Murrill 111.

Observations: In the dried condition the type reminds one of *P. longistriatus*. The colored pleurocystidia are abundant and distinctive. Apparently these are not present on the edge or, if so, they are very rare (we did not find any) and do not cause the gill edge to be colored. This is apparently the opposite of what Singer (1956) observed, but it is impossible to be sure since he did not describe each type of cystidium separately. Neither did we find pigment bodies in the colored pleurocystidia in the mounts we studied; KOH was the mounting medium used. As Singer pointed out, the species is easily recognized and distinctive.

PLUTEUS MYCENIFORMIS Murrill, North Amer. Flora **10**: 137. 1917.

Figs. 70-74. Cheilocystidia, spores, and pleurocystidia.

Pileus 3 cm. broad, convex, not expanding, surface glabrous, smooth or slightly striate, nearly white, yellowish on disc, margin white and incurved, entire to slightly lacerate; context thin and fragile.

Lamellae broad, subdistant, very thin and fragile, white to pale salmon-colored, entire and concolorous on the edges.

Stipe 2-3 cm. long, 2-3 mm. thick, short, subequal, smooth, glabrous, white.

Spores $7.5-9.5 \times 6-7.8 \mu$, broadly ellipsoid to subglobose, smooth, wall slightly thickened, hyaline to pale lilac in KOH under high oil-immersion; basidia $30-36 \times 8-10 \mu$, 4-spored; pleurocystidia $40-60 \times 10-20 \mu$, broadly to narrowly fusoid ventricose, apices obtuse or narrowed to a slight extension and subacute at the end of it, rarely subcapitate, hyaline, thin-walled, lacking incrustations; cheilocystidia $30-46 \times 12-16 \mu$, ventricose with an abrupt narrow neck and obtuse apex, or fusoid ventricose and gradually tapered to an obtuse apex; cuticular elements "elongated hyphae, in the center with plaques of brown pigment, terminal cells usually very broad at apex, rarely attenuate or subacute or capitate at apex." (Singer, 1956, p. 177); clamps, none found.

Habit, habitat and distribution: Solitary on dead wood, Cinchona, Jamacia, 1500 m. elevation. Dec. 25, 1908. Murrill 504.

Observations: Singer's description of the cuticular elements is included. Our sections showed only clavate smooth hyphal end-cells but we were not able to check the cuticular elements over the disc of the pileus.

It appears to us that the name is a bit unfortunate since a convex cap with an incurved margin indicates the aspect of *Collybia* rather than *Mycena*.

PLUTEUS NANELLUS Murrill, North Amer. Flora **10**: 130. 1917.

Figs. 75-78. Cuticular elements, spores and cheilocystidia.

Pileus 13 mm. broad, convex, not fully expanding, slightly umbonate, surface dry, apparently glabrous, but minutely tomentose under a lens, smooth, not striate, pale bay, castaneous on drying, margin concolorous, rivulose.

Lamellae free, crowded, ventricose, white to salmon-colored, the edges white and serrulate.

Stipe slender, 2 cm. long, 1-1.5 mm. thick, equal, smooth, glabrous, flattened on drying, snow white.

Spores $4.7-6 \times 4.5-5.5 \mu$, broadly ellipsoid to sub-globose, smooth, wall slightly thickened, content pale lilac under high oil-immersion; basidia 4-spored; pleurocystidia none found although hymenium revived fairly well; cheilocystidia $33-50 \times 10-18 \mu$, clavate to fusoid-ventricose, apices mostly broadly rounded to obtuse, rarely subacute, hyaline, thin-walled, readily collapsing; cuticle a combination of the turf and the palisade types—elements vesiculose-pedicellate, clavate, fusoid-ventricose (from broadly rounded at apex to acute) and fusoid, the elements all intermingled and upright to decumbent (largest ones), content smoky yellowish; caulocystidia mostly ellipsoid to clavate as in the elements of the cuticle; clamps none found.

Habit, habitat and distribution: Solitary on a dead log in woods, Lake Placid, Adirondack Mts., N. Y., July 17-29, 1912, W. A. Murrill 73.

Observations: Singer did not publish data from the type; he simply stated the species was a synonym of *Pluteus seliceps* (Atk.) Singer, and that species was described as having pleurocystidia. We simply cannot agree with Singer's statements about the cuticle containing "dermatocystidia". We have studied numerous species with this type of cuticle, and because of the complete intergradation of all morphological types occurring in the layer, believe that all the elements are to be interpreted simply as basic elements of the layer and that they cannot reasonably be separated into two categories of elements, one the elements of the epicutis and the other dermatocystidia, as is done by Singer. In the present state of our knowledge we do not accept the synonymy Singer gave.

PLUTEUS NIVEUS Murrill, North Amer. Flora **10**: 128. 1917.

Figs. 85-87. Pleurocystidia, cheilocystidia, and spores.

Pileus 2 cm. broad, expanded, surface minutely furfuraceous, white, margin not striate.

Lamellae free, subcrowded, broad, ventricose, white to pale pink.

Stipe 5 cm. long, 2 mm. thick, cylindric, glabrous, shining white.

Spores $6-7.5 \times 5-5.7 \mu$, broadly ellipsoid, pale lilac in KOH under high oil-immersion, smooth, wall slightly thickened; basidia 4-spored, $18-24 \times 5.6-8 \mu$; pleurocystidia abundant, slender, $55-67 \times 8-12 \mu$, narrowly ventricose, hyaline, smooth, no incrustations; cheilocystidia fusoid-ventricose, hyaline, thin-walled, smooth; cuticular elements filamentous, no good end-cells seen; clamps, none.

Habit, habitat and distribution: West Park, New York, Aug. 3, 1903, F. S. Earle 1698.

Observations: The pleurocystidia observed in our sections are not like those described by Singer (1956). Hence, we are inclined to believe that Singer's account is a composite description of the type and his New York collection and that it encompasses more than one taxon.

PLUTEUS PALLIDICERVINUS Murrill, North Amer. Flora **10**: 131. 1917.

Fig. 79, 88-90. Cheilocystidia, cuticular elements, pleurocystidia and spores.

Pileus 5 cm. broad, convex to expanded, not umbonate, regular, surface smooth, finely tomentose at least under a lens, pale isabelline,

dark isabelline or fulvous on the disc, margin entire, concolorous, not striate.

Lamellae free, broad, ventricose, crowded, white to salmon-colored.

Stipe 7 cm. long, 5 mm. thick, cylindric, solid, equal, smooth, glabrous, concolorous.

Spores $6-7 \times 5-5.5 \mu$, broadly ellipsoid to subglobose, smooth, wall thickened, content lilaceous (under high oil-immersion) to hyaline; basidia 4-spored, $26-32 \times 6.5-7.5 \mu$; pleurocystidia $50-67 \times 13-18 \mu$, fusoid-ventricose with thick ($12-13 \mu$) necks quite elongate, and obtuse apices with irregular outgrowths, or shape of cystidium varying to subcylindric and $13-15 \mu$ in diam.; cheilocystidia $35-46 \times 9-14 \mu$, fusoid-ventricose with acute to subacute apices, hyaline, thin-walled, smooth; cuticular elements of greatly elongated fusoid cells $15-33 \mu$ in diam. with long-tapered acute apices, thin-walled, content hyaline to yellowish; clamp connections, none found.

Habit, habitat and distribution: Gregarious on rotten wood, West Park, New York. Aug. 3, 1903. Earle 1643.

Observations: The species is not a member of the *P. cervinus* group; though it is very apt to be passed by, the collector thinking it is just a variant of *P. cervinus*.

PLUTEUS PULVERULENTUS Murrill, North Am. Flora **10**: 137. 1917.

Figs. 80-81. Spores, pleurocystidia, and cheilocystidia.

Pileus 2-3 cm. broad, obtuse, becoming convex to expanded, surface brown, glabrous, rugose-reticulate on disc, brown-pulverulent on margin, not striate; thin.

Lamellae free, subcrowded, broad, ventricose, white to salmon-colored, entire and concolorous on the edges.

Stipe 2 cm. long, 2 mm. thick, cylindric, glabrous, subconcolorous.

Spores $(5)6-7.6 \times 5.8-7 \mu$, globose-ovate to subglobose, wall slightly thickened, pale lilaceous in KOH under high oil-immersion, smooth, apiculate; basidia 4-spored, $18-23 \times 6-8 \mu$; pleurocystidia scattered, $50-57 \times 15-24 \mu$, broadly ventricose with rounded apices, thin-walled, readily collapsing, apex typically with a large cap of dried mucilage (revived in KOH), content hyaline, mucilaginous incrusting material brownish; cheilocystidia similar to pleurocystidia except that fewer showed incrustations; cuticle of pileus a palisade of inflated to pedicellate-globose cells with dark brown content; clamp connections, none found (material poorly revived).

Habit, habitat and distribution. Solitary on the ground at The Bower, St. George's, Grenada, West Indies. Sept. 10, 1905, W. E. Broadway.

Observations: In our study of the type we found the spores, when properly oriented, were not "almost geometrically globose" as pointed out by Singer (1956) but rather almost *wider than long in face view* and tapered to the apiculate end to give a shape we describe as globose-ovate. In side view the shape is typically subglobose varying toward broadly ellipsoid. At least some spores are broader by a few tenths of a micron than they are thick, which indicates a trend toward a compressed spore as found in certain other groups of agarics. We did not find mucronate cheilocystidia as illustrated by Singer but are not

inclined to emphasize this "difference" because of the difficulties involved in working with the material. As to the condensed brown pigment bodies in the cells of the epicutis which Singer referred to, we believe this is an artifact. When we obtained well revived cells the brown pigment was evenly dissolved in the cell sap just as it always is in this group. We used 3 percent KOH.

PLUTEUS RETICULATUS Murrill, *Mycologia* **3**: 276. 1911.

Figs. 82–84. Pleurocystidia, cheilocystidia, and spores.

Pileus 5 cm. broad, about 1 cm. thick, plane to depressed, umbonate, surface velvety, dark isabelline with pale fuliginous reticulations which are more pronounced on the umbrinous umbo.

Lamellae free, ventricose, salmon-colored.

Stipe 4 cm. long, 5 mm. thick, cylindric, subequal, glabrous, stramineous with a pale melleous tint.

Spores $5.5\text{--}6.5 \times 4\text{--}5 \mu$, broadly ellipsoid to subglobose, thin-walled, (many remain collapsed), lilaceous in KOH under high oil-immersion; pleurocystidia $(60)70\text{--}90 \times (10)14\text{--}22 \mu$, fusoid to sub-cylindric with acute apices, wall thickened up to 2μ or more in apex, yellowish in KOH becoming hyaline, no ornamentation whatever; cheilocystidia $30\text{--}40 \times 9\text{--}13 \mu$, broadly fusoid, with slight thickening in wall at apex (this was the only kind seen); cuticle of appressed hyphae—badly obscured by hyphae of an imperfect fungus; clamp connections, none.

Habit, habitat and distribution: Solitary on dead wood, Mon-eague, Jamaica, Jan. 17–18, 1909, Murrill 1159.

Observations: Since Murrill described large fusiform cystidia for this species, and we found these on the part of the type we studied, we are accepting the above data as authentic, and consider that Singer somehow studied a specimen of some other species. *P. reticulatus* obviously belongs in the *Pluteus cervinus* group.

PLUTEUS RIMOSUS Murrill, *Mycologia* **3**: 276. 1911.

Figs. 91–92. Cheilocystidia and spores.

Pileus 4–5 cm. broad, 2–3 cm. high, conic to convex, surface fuliginous when young, becoming umbrinous, smooth, glabrous, at length radiate-rimose and showing white in the cracks.

Lamellae free, close, rather narrow, white becoming roseous from the spores.

Stipe 4.5 cm. long, scarcely 1 cm. thick above, 2 cm. thick at base, white, glabrous, crooked.

Spores $5\text{--}5.7 \times 4.5\text{--}5 \mu$, subglobose to globose, smooth, thin-walled but not collapsing, lilaceous in KOH under high oil-immersion; basidia 4-spored; pleurocystidia scattered to rare, $22\text{--}33 \times 10\text{--}14 \mu$ vesiculose-pedicellate, hyaline, thin-walled, collapsing; cheilocystidia similar to pleurocystidia; cuticle a palisade of clavate to vesiculose-pedicellate cells with dark brown content (none seen which were cystidioid); clamp connections, none.

Habit, habitat and distribution: Gregarious in a field on soil mixed with decayed wood, Port Antonio, Jamaica, Dec. 17, 1908, Murrill 214.

Observations: By virtue of the small vesiculose pleurocystidia,

small spores, and thick stipe, the species appears to be readily distinguished in its own right. Singer's comment that it might be considered the same as *P. reticulatus* must be discounted in the light of our findings on the latter.

PLUTEUS RUGOSODISCUS Murrill, North Amer. Flora **10**: 129. 1917.

Figs. 93-96. Pleurocystidia, spores, cheilocystidia, and collapsed cuticular elements.

Pileus 1-1.5 cm. broad, convex to nearly expanded, slightly umbonate, surface glabrous, moist, greenish-yellow, smoky-green on disc, with pruinose reticulate raised radiating lines, margin entire, concolorous, not striate.

Lamellae free, broad, ventricose, crowded, inserted, white to salmon-colored, entire and concolorous on the edges.

Stipe 2.5 cm. long, 1 mm. thick, slender, equal, smooth, glabrous, greenish yellow, whitish tomentose at base.

Spores $5.7-6.6 \times 5-5.5 \mu$, broadly ellipsoid, smooth, wall slightly thickened and yellowish in KOH (under high oil-immersion), basidia 4-spored, $30-36 \times 7-9 \mu$, often with rather long pedicels; pleurocystidia abundant, $(40)50-70(77) \times 10-15 \mu$, fusoid-ventricose with neck tapered to an obtuse apex, with hyaline to yellowish incrustations of amorphous material on neck or midportion; cheilocystidia similar in shape to pleurocystidia but smaller, $23-37 \times 8-11 \mu$ thin-walled, hyaline and usually not incrustated; cuticle of pileus a palisade of clavate-pedicellate cells yellowish to hyaline in KOH (poorly revived); clamp connections, none.

Habit, habitat and distribution: Solitary on dead wood in deciduous woods, Falls Church, Virginia, July 2-6, 1904. W. A. Murrill 111.

Observations: The reticulate raised lines on the cap may not be a constant feature. The pleurocystidia are not rounded in the sense that we use this term.

PLUTEUS SPINULOSUS Murrill, North Amer. Flora **10**: 138. 1917.

Figs. 97-99. Cheilocystidia, pleurocystidia, and spores.

Pileus 4-5 cm. broad, convex, glabrous, subviscid, avellaneous, darker on the disc, margin not striate.

Lamellae free, crowded, narrow, white to salmon-colored, *brownish* and *pruinose on the edges*.

Stipe cylindric, 4-5 cm. long, 3-4 mm. thick, enlarged at the base, glabrous, concolorous.

Spores $6.5-8.8(9) \times 6-7.5 \mu$, broadly ellipsoid to sub-globose, smooth, wall thickened slightly, pale lilaceous in KOH under high oil-immersion; basidia 4-spored, $28-36 \times 6-7.5 \mu$; pleurocystidia very abundant, $(50)60-90 \times 10-20 \mu$, fusoid-pointed and *smooth* to more or less covered with lateral ornamentation, walls $2-3.3 \mu$ thick near apex (thinner near gill edge); cheilocystidia variable: 1) clavate to fusoid-ventricose to mucronate or variously contorted and *thin-walled*, with or without lateral protuberances in the wall of the neck, $30-45 \times 9-14 \mu$; 2) ventricose with elongated thin ornamented necks and wall of neck slightly thickened, $40-65 \times 10-15 \times 4-8 \mu$, and some merely fusoid and ornamented like the pleurocystidia but smaller; cuticle a

pellicle of radial narrow hyphae, only subgelatinous in KOH; clamps present.

Habit, habitat and distribution: British Honduras, 1906, Morten E. Peck, collector.

Observations: This species is well characterized by virtue of the clamp connections, colored gill edges, and lateral ornamentation on many of the pleurocystidia. Smith (1939) and later Singer (1956) both missed the really significant facts about this fungus, probably because they had their attention focused on the lateral ornamentation of the metuloids. These facts are that many of the pleurocystidia (metuloids) are *smooth* and *fusoid* as in *P. reticulatus*, and that there is great variation in the ornamentation of the cheilocystidia including the metuloids almost at the gill edges (fig. 100). Both of these are important characters in the *Pluteus cervinus* group.

PLUTEUS UNAKENSIS Murrill, North Amer. Flora **10**: 129. 1917.

Figs. 100–103. Cheilocystidia pleurocystidia, spores, and cells from cuticle of pileus.

Pileus 2 cm. broad, convex to expanded, thin; surface densely silky fibrillose, grayish-white, darker on the umbo, margin striate.

Lamellae free, crowded, narrow, white to pink.

Stipe 4–5 cm. long, 2–3 mm. thick, cylindric, minutely fibrillose.

Spores $5-6 \times 3.5-3.8 \mu$, oblong to ellipsoid, smooth, wall very slightly thickened, content only faintly lilac in KOH under highest oil-immersion: basidia 4-spored, $13-16 \times 5-6 \mu$; pleurocystidia scattered, $40-57 \times 16-25 \mu$, pedicellate and broadly ventricose above and tapered slightly to a broadly rounded apex, or tapered evenly to a subacute to papillate apex, thin-walled, hyaline; cheilocystidia either similar to pleurocystidia (rare) or (abundant) fusoid-ventricose with obtuse to subacute apices, $22-38(44) \times 8-14 \mu$, hyaline, smooth and thin-walled; cuticular elements of gigantic cylindric cells ($25-35 \mu$ in diam.) with rounded apices or these somewhat cystidioid, typically forming a turf, all seen were hyaline as revived in KOH; clamp connections, none.

Habit, habitat and distribution: In mixed woods, Unaka Springs, Tenn., Aug. 18–24, 1904. W. A. Murrill 853.

Observations: Singer (1956) apparently failed to observe the typical small cheilocystidia of the type, and in his Michigan collection described only relatively narrow pleurocystidia. We do not admit his N394 to the species. Spores of the type shown by *P. unakensis* are not too uncommon in *Pluteus*, as we have discovered in the *P. cervinus* group. The gigantic cuticular elements appear to us to be one of the distinctive features of the species.

PLUTEUS WHITEAE Murrill, North Amer. Flora **10**: 132. 1917.

Figs. 104–108. Pleurocystidia, spores, cheilocystidia, and apical portion of cells from cuticle of pileus.

Pileus 5 cm. broad, convex, not expanding, not umbonate, regular, surface dry, minutely granular, golden-brown or ochraceous-fulvous, umbrinous-avellaneous on the disc, margin entire, concolorous, faintly striate; context with a mild taste.

Lamellae free, rather broad and crowded, white to salmon-colored.

Stipe 7 cm. long, 8 mm. thick, equal, smooth, glabrous, shining, white, somewhat compressed and twisted, stuffed to hollow.

Spores $5.5-6.5 \times 5-5.5 \mu$, smooth, broadly ellipsoid, smooth, wall slightly thickened, content pale lilac in KOH under high oil-immersion; basidia 4-spored, $19-25 \times 6-7 \mu$; pleurocystidia abundant to scattered, of two types: 1) $60-90 \times 20-36 \mu$, broadly rounded apex, content hyaline to yellowish, smooth, *thin-walled throughout*; type 2) $40-55 \times 11-15 \mu$, fusoid-ventricose to an obtuse to subacute apex, *thin-walled throughout*, with pale dingy yellowish content in KOH, smooth; cheilocystidia $36-50 \times 12-25 \mu$, broadly fusoid ventricose to a subacute apex and little or no neck, *wall in ventricose part slightly thickened and refractive as in metuloids, thin-walled* in the apex or short neck, hyaline, smooth, not readily collapsing; cuticular elements of greatly elongated fusoid cells with elongated narrow necks and acute apices, $20-35 \mu$ in diam. (too long to measure), thin-walled, hyaline, smooth; clamp connections, none observed but possibility of their presence not excluded.

Habit, habitat and distribution. Solitary on decayed wood at Bar Harbor, Maine, Aug. 11, 1901. V. S. White 91.

Observations: The outstanding feature of this species is the slightly thickened somewhat refractive wall of the ventricose part of the cheilocystidium, which causes this part to be readily visible in revived mounts as compared with the thin-walled non-refractive neck which is readily seen only when one focuses carefully upon it. The result of this situation is that at first glance the apex of the cheilocystidium appears to be missing. The hymenium of the type revives well and both types of pleurocystidia were clearly seen. The proportion of either kind on any one section of a gill varies and in some gills only one may appear to be present—all this in a single pileus. Only one pleurocystidium with apical appendages was found. We could not establish either the presence or absence of clamp connections with any degree of certainty.

LITERATURE CITED

- Kühner, R. et Henri Romagnesi. 1953. Flore Analytique des Champignons Supérieurs. pp. 556. Masson et C^{ie}, Paris.
Singer, Rolf. 1956. Contributions Toward a Monograph of the genus *Pluteus*. Trans. British Myc. Soc. **39**(2): 145-232.

Some Tremellaceous Fungi in the C. G. Lloyd Collection

R. J. BANDONI

(University of British Columbia, Vancouver, Canada)

In his Mycological Writings, C. G. Lloyd described a number of new species of *Tremella* which he and his correspondents had collected in various parts of the world. Since his descriptions were based largely upon macroscopic external characteristics, they are inadequate for purposes of identification. Through the courtesy of Mr. J. A. Stevenson, of the Bureau of Plant Industry, a number of Lloyd's specimens were obtained and the following descriptions of microscopic characteristics were prepared from them. In some instances the names published by Lloyd have been found to be synonyms of older binomials and these have been noted here. However, because of the confused state of the taxonomy of this genus, no attempt has been made to give complete synonymy for each species. Descriptions are given for a few species described by other authors and reported by Lloyd in the Mycological Writings.

The number cited for each specimen is the Smithsonian serial number as listed by Stevenson and Cash (Lloyd Library Bull. **35**: 34-37. 1936) and all species are arranged alphabetically for convenience. Examination of the material was by means of thin free-hand sections stained by the Phloxine-KOH technique described by Martin (Mycologia **26**: 264. 1934). In some instances a strong aqueous solution of Congo Red was used in place of the Phloxine, or in conjunction with it, in order to stain the hyphal walls. An ammoniacal solution of Congo Red, as suggested by Bourdot and Galzin (Hym. Fr. ii. 1928) was also found to be useful for this purpose.

TREMELLA ATER-GLOBOSA Lloyd. See *Tremella moriformis*.

TREMELLA AUSTRALIENSIS Lloyd, Myc. Writ. **4**: L. 45, p. 7. 1913.

Fig. 1

Foliaceous, the lobes caespitose, thick, firm-gelatinous, drying yellowish to rust-color; hyphae thin-walled, with clamps, occasionally swollen at the septa, $1.5-5\ \mu$ in diam., closely interwoven, bearing gemmae¹ on short lateral branches; gemmae pyriform to obovate, thin-walled, $8-13 \times 5-9\ \mu$; hymenium amphigenous, forming a compact surface layer consisting of an erect pallisade of parallel hyphae, each bearing one or two basidia terminally, or the basidia borne apically on moniliform chains of vesiculose cells separated by clamps; probasidia mostly pyriform or obovate, a few clavate, oval, or subglobose, cruciately to irregularly 3-septate, $10.5-19.5 \times 8-13\ \mu$; epibasidia $50\ \mu$ or more

¹The exact nature of the structures here designated by this term is not known at present. They are borne on short lateral branches from hyphae of the context, are subtended by clamps, and sometimes appear to germinate by the production of a germ tube. These spore-like structures seem to be consistently present in the species in which they occur and their form is relatively constant in each species, indicating that they may be of some taxonomic value. It appears possible that they represent basidial initials which have failed to develop.

in length, $2-3\ \mu$ in diam., swollen apically; basidiospores ovate to subglobose, $8-10.5 \times 7-9\ \mu$; conidia abundant, produced on vesiculose cells interspersed with the basidia and arising from the same hyphae as the latter, globose to oval, about $2.5-4 \times 1.5-3.5\ \mu$.

This species is known from a single specimen, no. 4010, collected by G. H. Adcock, Victoria, Australia. A note with the specimen indicates that the color when collected was clear yellow and darkened upon drying. In addition to the gemmae, there are present, on the hyphae, spherical or elongate cells subtended by clamps, from which one or more thread-like hyphae radiate (fig. 1, g). It has been suggested (Olive, *Mycologia* 38: 540. 1946) that these structures may be haustoria, but their presence in this and other non-parasitic species would require some other explanation. Their position and appearance in some species suggests that possibly they are conidia or gemmae which have germinated while still attached.

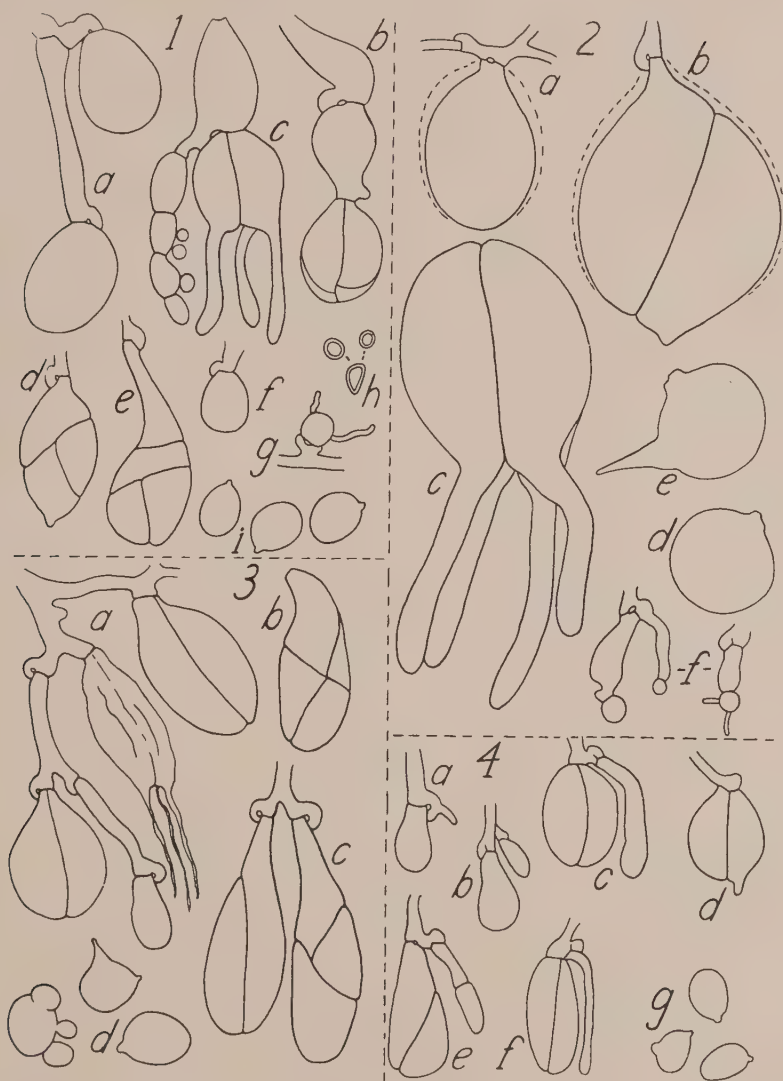
TREMELLA BRASILIENSIS (Möller) Lloyd, *Myc. Writ.* 7: 1152. 1924. f. 2239.

Tremella lutescens forma *brasiliensis* Möller, *Protobas.* 100. 1895.

Fig. 2

Erumpent from the cortex of dead branches, at first cerebriform, becoming foliaceous, the lobes thick, gelatinous, the color, when dry, pale yellow (according to Möller, at first fiery red, becoming yellow); hyphae with clamps, about $2-3\ \mu$ in diam., but often with thick gelatinous sheaths and the diameter then somewhat greater; hymenium amphigenous, embedded about $10-30\ \mu$ below the surface and forming a broad but loosely packed zone of basidia, these arising on short branches from a fertile network of hyphae; probasidia pyriform to oval or subglobose, longitudinally cruciate-septate, $26-40(-48) \times 22-27(-32)\ \mu$, epibasidia as long as $100\ \mu$, $4-7\ \mu$ in diam., slightly swollen apically; basidiospores globose or subglobose, with a large blunt apiculus, $13-20 \times 13-18\ \mu$; germinating by repetition; conidial formation, when present, preceding basidial production, the conidiophores and conidia forming an amphigenous surface layer up to $150\ \mu$ in thickness, the conidia globose to oval or elliptic, $2.5-9 \times 1.5-4\ \mu$; structures resembling conidia present outside the hymenia of mature fructifications (fig. 2, f) and appearing to germinate while still attached.

There are three specimens designated by this name in the Lloyd Collection, all of which were collected by J. Rick in Brazil. Unfortunately, all do not seem to be the same species and one consists only of the conidial stage. Specimen no. 4014 was the first specimen received by Lloyd from Rick and bears only conidia. The remaining two, nos. 38792 and 38799 bear basidia but are unlike. No. 38792 is small, but is in much better condition than the remaining specimen and seems to be distinct from any other described species. Examination of other specimens identical with it, G. W. Martin nos. 2688, 2246, 2049, all collected in the province of Chiriquí, Panamá, and specimens collected by Rick in Brazil, reveals that this species often has the basidial stage preceded by a conidial stage indistinguishable from that of no. 4014. Therefore, unless Möller's material can be found, it would seem best to designate no. 38792 as the neotype of this species.



All figures drawn with the aid of a camera lucida and reduced in reproduction to approximately $\times 1000$.

FIG. 1. *Tremella australiensis* Lloyd. a, b. Probasidia. c. Mature basidium and conidiophore. d, e. Mature probasidia. f. Gemmae. g. Conidium-like structure with germ tubes (?) h. Conidia. i. Basidiospores.

FIG. 2. *Tremella brasiliensis* (Möller) Lloyd. a, b. Probasidia with thick gelatinous sheaths. c. Mature basidium. d, e. Basidiospores the latter germinating by repetition. f. Conidium-like structures.

FIG. 3. *Tremella candida* Lloyd. a. Fertile hypha bearing probasidia and a spent basidium. b, c. Mature probasidia. d. Three basidiospores, one germinating by budding, another by repetition.

FIG. 4. *Tremella cinnabarina* (Mont.) Pat. a-f. Probasidia in various stages of development. g. Basidiospores.

The species is distinguishable from all others that I have seen by the very large basidia and spores.

TREMELLA CANDIDA Lloyd (not *T. candida* Pers.), Myc. Writ. **5**: 851. 1919. f. 1425.

Fig. 3

Fructification consisting of an effused portion bearing more or less foliaceous lobes, gelatinous, white, drying yellowish; hyphae thin-walled, with clamps, septate, $2-5\ \mu$ in diam., bearing gemmae; gemmae abundant, thin-walled, obovate to subglobose, $8-14 \times 5-8\ \mu$; hymenium forming an amphigenous surface layer, the basidia borne terminally on erect hyphae and lateral proliferation of the hyphae then occurring; probasidia clavate to pyriform or oval, sometimes pedicellate, becoming longitudinally or obliquely cruciate-septate, $13-24(-35) \times 8-14.5\ \mu$; epibasidia up to $100 \times 2-3\ \mu$; basidiospores broadly ovate or subglobose, flattened adaxially, $8-11 \times 6.5-8.5\ \mu$, germinating by repetition, by budding, or by germ tube.

Represented by a single specimen, no. 3992, collected by Yasuda in Japan. A note with the specimen, probably Yasuda's, lists the spores as elliptical, $8 \times 5\ \mu$. Lloyd stated that the spores were subglobose, $7-8\ \mu$, and Kobaysai (Tokyo Bunr. Diag. Sci. Rep. **4**: 12. 1939) lists them as subglobose, $7.7-10.5 \times 6.3-7.7\ \mu$. Kobayasi cites as the authority for this species, both Yasuda and Yasuda ex Lloyd. I could find no reason for this other than the fact that Yasuda collected the type specimen.

TREMELLA CARNEOCOLOR Lloyd, Myc. Writ. **7**: 1363. 1925, f. 3254.

The type specimen, no. 4005, J. Libunao, com. O. A. Reinking, Mt. Maquiling, Philippine Islands, Sept. 1920, is a dacrymycetaceous fungus, possibly *Dacryopinax elegans* (Berk. & Curt.) Martin.

TREMELLA CINNABARINA (Mont.) Pat. Essai Tax. 20, 21. 1900.

Naematelia cinnabarina Mont. Ann. Sci. Nat. Bot. III. **20**: 120. 1848.

Tremella samoensis Lloyd, Myc. Writ. **5**: 875. 1919, f. 1495.

Tremella cinnabarina (Mont.) Lloyd (as McGinty), Myc. Writ. **7**: 1150. 1922.

Fig. 4

Fructification consisting of an expanded prostrate portion from which small foliaceous lobes arise, firm-gelatinous, brownish-orange when dry, soaking to pale yellow; hyphae with clamps, $1.5-4\ \mu$ in diam., or sometimes with thick gelatinous sheaths and the diameter then somewhat larger; hymenium amphigenous, forming a compact surface layer, the hyphae bearing basidia terminally, then proliferating laterally; probasidia mostly elongate, oval or obovate, longitudinally cruciate-septate, $10-17 \times 8-12\ \mu$; epibasidia generally less than $20\ \mu$ in length, $2\ \mu$ in diam., slightly swollen apically; basidiospores broadly ovate, flattened adaxially, $6-8 \times 4-6\ \mu$, germinating by repetition or by budding; no conidia seen.

Specimens examined include nos. 3824 (a fragment of the type of *Naematelia cinnabarina*) collected in Tahiti by J. Lepine; 4000 (type of *T. samoensis*), C. G. Lloyd, Samoa, 1905; 3996, 4011, 4021, 4023, 27038, 27075, 27076, and 27077, all collected at Mt. Maquiling, Luzon,

Philippine Islands, and sent to Lloyd by Otto A. Reinking. There are no significant differences in the microscopic characteristics of the two type specimens and the appearance does not suggest that of *T. mesenterica*, as was stated by Lloyd (Myc. Writ. 7: 1150. 1922). Since the color of tremellaceous fructifications often fades considerably or changes upon drying, the criticism by Lloyd of the color designated by the specific epithet is perhaps not just. The variability in color from specimen to specimen and alteration of it during the development or drying of a fructification makes this character one of questionable value.

Kobayasi (Tokyo Bunr. Diag. Sci. Rep. 4: 10. 1939) described a new variety of this species which he separated on the basis of spore shape. Lloyd stated that the spores were globose, but most of them are distinctly ovate and not sufficiently different in size from those of the variety to warrant the varietal designation. The variety was later elevated to specific rank by Ito and Imai (*T. boninensis*, Trans. Sapporo Nat. Hist. Soc. 16: 33. 1940).

There appear to be some minor differences between specimens from Samoa and those from the Philippine Islands, but not sufficient to designate them as separate species.

TREMELLA CLAVARIOIDES Lloyd, Myc. Writ. 3: Old sp. 10. 1908, f. 224.

There are several specimens designated as this in the Lloyd Collection and all can be referred to *T. reticulata* (Berk.) Farl. Lloyd also used the name *Corticoides reticulatum* in his discussion of this species.

TREMELLA COMPACTA Möller, Protobas. 107. 1895, pl. 1, f. 2.

Tremella pallida Overholts, in Seaver & Chardon, Bot. Puerto Rico and Virgin Isls.; Mycology 8: 147. 1926.

Fig. 5

Cerebriiform or less often, with thick foliaceous lobes, the fructifications reaching 2-3 cm in diam. and height, the larger lobes becoming hollow, firm-gelatinous, ochraceous, becoming pale brown and very hard upon drying, not shrinking greatly upon drying; soaking up slowly; hyphae much branched, with small clamps, compactly interwoven, mostly 1.5-4 μ in diam., a few somewhat larger, darkly staining hyphae scattered throughout the interior, sometimes penetrating the hymenium and resembling gloeocystidia; gemmae borne on short lateral branches, oval to subcylindric, often thick-walled, 6-13 \times 2-3 μ ; hymenium amphigenous, forming a compact surface layer, a few scattered basidia as deep as 80-90 μ , the fertile hyphae erect, often with moniliform areas of vesiculose cells terminated by one or two basidia, or the basidia borne terminally or alternately on slender hyphae; probasidia mostly obovate or oval, longitudinally to obliquely cruciate-septate, a few cylindrical or subcylindrical with one or two transverse septa, 10-17 \times 7-12(-15) μ ; epibasidia up to 100 \times 1.5-2 μ , inflated up to 5 μ at the apex; basidiospores ovate, flattened adaxially, 6-9 \times 4.5-6 μ , germinating by repetition; hymenial conidia borne on same hyphae as basidia, globose to oval, 2-4 \times 2-3 μ .

This description is based upon a specimen collected by Torrend, no. 3999, Bahia, Brazil, and others in the herbaria of the New York

Botanical Garden and the State University of Iowa. A specimen collected by J. Rick in Brazil and identified as this species by Lloyd, no. 4019, does not fit Möller's description and bears no resemblance to the specimen collected by Torrend. The type of *T. pallida* Overholts from Puerto Rico, coll. Seaver and Chardon, 1923, seems to be this same species.

TREMELLA CRASSA Lloyd, Myc. Writ. 7: 1148. 1922, f. 2215.

The type specimen, no. 4020, P. van der Bijl, U. of So. Africa, appears to have been in an advanced state of decomposition when collected. I could not find any basidia in it, and though there were numerous spores present, they probably belonged to other fungi which grew on the fructification. There is nothing present to indicate definitely that it is a *Tremella*.

TREMELLA CRISPA Lloyd, Myc. Writ. 7: 1152. 1922, ff. 2237, 2238.

Fig. 6

The specimen upon which Lloyd based this name, no. 4004, was sent to him by Rodway from Tasmania. A note with the specimen indicates that the same thing had been sent to Massee earlier and had been determined as *Tremella vinosa* by him. Lloyd apparently knew that the name had been published by Massee, but thought that the combination had already been used by Berkeley and Curtis. *T. vinosa*, as used by Berkeley and Curtis, was an herbarium name for an Ascomycete, *Sarcomyces vinosa* Massee, and was never published by them. The type specimens of both species were examined and appear to be the same. Furthermore, they seem not to be distinct from specimens generally referred to as *T. foliacea* Fr. in north temperate regions. The specimen sent to Lloyd is unusual in several respects, but transitional forms between it and the more typical specimens can be found. It has a layer of sterile hair-like structures just outside the hymenium (fig. 6, b) and the basidia have thick brownish walls surrounded by gelatinous sheaths. The sterile hair-like structures can be found in specimens from Europe and America, but they usually do not form a continuous and compact layer. A specimen collected at Port Arthur, Tasmania, and sent to G. W. Martin by J. B. Cleland is intermediate in this respect. The basidia of most specimens of *T. foliacea* have brownish walls, and thick, gelatinous sheaths surrounding the basidia are not uncommon in this and other species of *Tremella*.

TREMELLA FIBULIFERA Möller, Protobas. 119. 1895, Pl. 2, f. 3.

Fig. 7

Effused over wood or litter with cerebriform or foliaceous lobes, very soft, gelatinous, white, drying to an inconspicuous yellowish film; hyphae with conspicuous open-type clamps at the septa and often at points of branching, the diameter of the loop formed sometimes approaching $20\ \mu$, the filaments $2.5\text{--}9\ \mu$ in diam.; hymenium forming an amphigenous surface layer, many deeply embedded basidia present also, the fertile hyphae bearing basidia terminally and proliferating laterally; probasidia mostly oval, some obovate or subglobose, often with a broad base and clamp, longitudinally cruciate-septate,

11–19(–22) \times 11–14(–18) μ ; epibasidia 2–3 μ in diam., swollen to 4–5 μ apically, frequently reaching 130 μ in length; basidiospores ovate, 8–10.5 \times 5–7 μ , germinating by repetition or by budding; conidiophores and conidia sometimes produced, arising from the same hyphae as the basidia, the conidia oval or irregular, about 3 \times 2 μ .

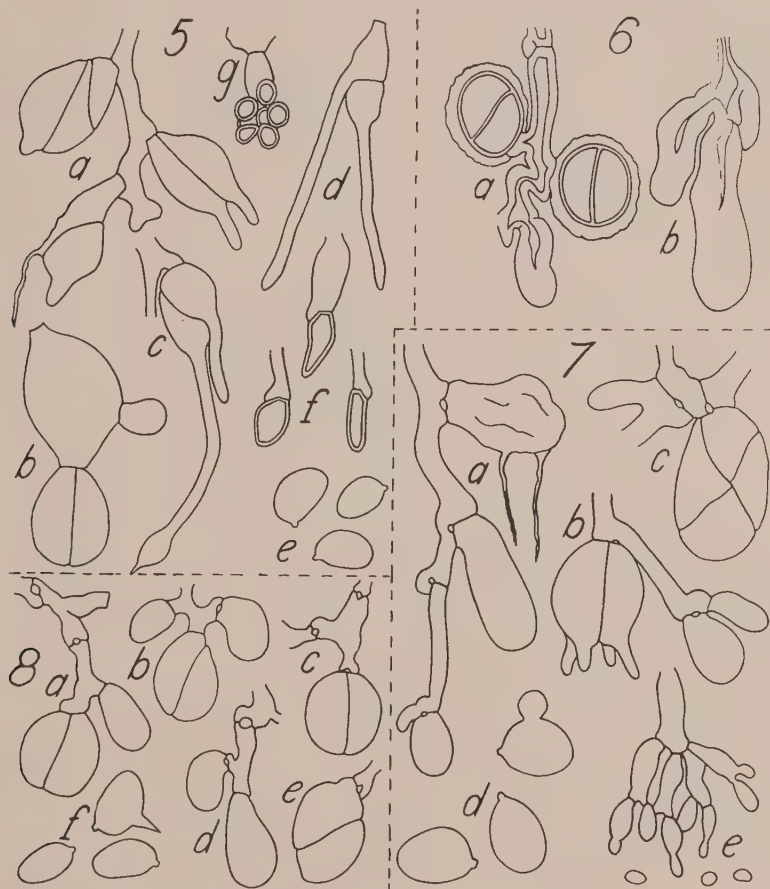


FIG. 5. *Tremella compacta* Möller. a, b. Fertile hyphae showing arrangement of basidia. c, d. Mature 2-celled basidia with Auricularia-like septation. e. Basidiospores. f. Gemmae.

FIG. 6. *Tremella foliacea* Fries (From type of *T. crispa* Lloyd). a. Fertile hypha bearing two probasidia with thick gelatinous sheaths. b. Sterile structure from the hymenium.

FIG. 7. *Tremella fibulifera* Möller. a-c. Fertile hyphae showing arrangement and development of probasidia and basidia. d. Three basidiospores, one germinating by budding. e. Conidiophore and conidia.

FIG. 8. *Tremella fuciformis* Berk. a-e. Probasidia in various stages of development. f. Basidiospores, one germinating by repetition.

The species was reported by Lloyd (Myc. Writ. 7: 118. 1922) on the basis of a specimen, no. 4013, sent by Torrend from Brazil. This proves to be another species, possibly *T. compacta* Möller. This description is based upon specimen no. 3857, collected by Torrend in Brazil and determined by Lloyd as *T. fuciformis* Berk. and upon specimens in the herbarium of the State University of Iowa, G. W. Martin nos. 2262, 2625 and 7536, collected in Panamá, and 8312, collected in Costa Rica.

Möller noted the ephemeral nature of this species and all collections which I have examined are in rather poor condition. A species described from Tasmania by Berkeley, *T. olens*, appears to be very close to this, but further collections of it will be necessary to establish the identity of the two.

TREMELLA FLAVIDULA Lloyd, Myc. Writ. 7: 1276. 1924, f. 2827.

Fig. 15

Foliaceous, the lobes thin, caespitose, soft-gelatinous, yellowish when dry, almost white when soaked; hyphae with clamps, often nodose, mostly $1-3\ \mu$ in diam.; hymenium forming a thick but loosely packed surface zone; probasidia at first oval to narrowly clavate, becoming obovate or oval, less commonly subglobose, longitudinally to obliquely cruciate-septate, $18-27 \times 15-18\ \mu$; epibasidia up to $50\ \mu$ in length, $3-5\ \mu$ in diam., often swollen to $7.5\ \mu$ at the apex; basidiospores oval to broadly ovate, flattened adaxially, with a large blunt apiculus, $12-15 \times 7.5-9\ \mu$, germinating by repetition.

The type specimen, no. 29500, was collected by N. C. Fassett, West Brookfield, Mass., on living Viburnum. Lloyd suggests that the species is intermediate between *T. lutescens* and *T. fuciformis*. It is certainly distinct from the latter, but may be closely allied to, or possibly identical with, the form designated as *T. lutescens* in Europe.

TREMELLA FUCIFORMIS Berk. Jour. Bot. & Kew Misc. 8: 277. 1856.

Fig. 8

Foliaceous, the lobes caespitose, repeatedly forked or lobed, or with margins incised or crenate or sometimes entire, crisped, undulate, gelatinous, white, drying pale yellow; in section, the lobes usually thin, the hymenium forming a compact, amphigenous, surface layer; hyphae $1-3.5\ \mu$ in diam., with clamps, sometimes nodose or with the wall irregularly thickened or with thick gelatinous sheaths; probasidia borne on a network of short, broad cells, obovate to oval or subglobose, becoming longitudinally cruciate-septate, $10-15(-18) \times 7-12\ \mu$; epibasidia $1.5-3\ \mu$ in diam., mostly under $30\ \mu$ in length; basidiospores ovate, flattened adaxially, $7-9 \times 4-6.5\ \mu$, germinating by repetition; conidiophores, when present, borne on the same hyphae as the basidia, the conidia forming capitate clusters, oval to subglobose, about $2-4 \times 2-3\ \mu$.

This description is based upon the type specimen at Kew and on those in the Lloyd Collection which seem to be the same. Lloyd referred to this species, specimens from Brazil, Chile, the Philippines, South Africa, West Africa, Australia and Singapore. He also reported on the distribution of *T. fuciformis* in North America (Myc. Writ. 5:

790. 1918). A number of these, from Chile, Africa, Singapore, and others, appear possibly to be some other species. I have examined material which compared favorably with the type from Brazil, Panama, Mexico, Florida, Alabama, South Carolina, North Carolina, Kansas and Iowa. Further study of this species is needed in order to determine the actual distribution.

TREMELLA FUSCA Lloyd (not *T. fusca* DC.), Myc. Writ. **5**: 683. 1917, f. 1021.

The type specimen, no. 4009, collected by C. Torrend, Bahia, Brazil, is a *Sirobasidium* and does not seem to be distinct from *S. sanguineum* Lagerh. & Pat.

TREMELLA GLAIRA Lloyd, Myc. Writ. **5**: 874. 1919.

The species is now placed in the genus *Exidiopsis* (Wells, Lloydia **20**: 48. 1957).

TREMELLA GYROSO-ALBA Lloyd ex Stevenson & Cash, Bull. Lloyd Lib. (Myc. Ser. 8) **35**: 35. 1936.

The type specimen, no. 3991, collected by D. S. Welch, Ithaca, N. Y., is *Sebacina epigea* (Berk. & Br.) Bourd. & Galzin.

TREMELLA HEMIFOLIACEA Lloyd, Myc. Writ. **7**: 1338. 1925, ff. 3104, 3105.

The type specimen, no. 2497, collected by E. M. Doidge, Knysna, Cape Province, U. of So. Africa, consists of an effused gelatinous mass, somewhat cerebriform in spots. The color noted by the collector was "dirty white" but it is almost black now. Sections of the fructification do not have a definite hymenium and old collapsed basidia are scattered throughout the entire thickness. A large number of foreign fungus spores, hyphae, and bacteria are present, indicating that the specimen was past its prime when collected. While the collapsed basidia are definitely tremellaceous, this fungus could conceivably have been a *Sebacina*, *Exidia*, *Heterochaete*, etc., and the species is doubtful at best.

TREMELLA HISPANICA Lloyd, Myc. Writ. **5**: 872. 1919, ff. 1487, 1488.

The type specimen, no. 41878, was collected by C. de Aranzadi, Barcelona, Spain, and was at first referred to the genus *Clavariopsis* by Lloyd (Myc. Writ. **4**: L. 42: 2. 1912). The specimen may have been white as described by Lloyd, but the lack of color could also have been due to a preservative in which it has at some time been placed. The basidia are very badly plasmolyzed and little could be learned about the microscopic characteristics of the fungus. While there is little doubt that it is a *Tremella*, the external appearance alone is insufficient to distinguish it from several other European species.

TREMELLA INCISA Lloyd, Myc. Writ. **7**: 1274. 1924, f. 2819.

There is no specimen of this in the Lloyd Collection and the illustration indicates that it may have been *T. reticulata* (Berk.) Farl.

TREMELLA ISABELLINA Lloyd, Myc. Writ. 7: 1357. 1925, f. 3201.

Fig. 16

Foliaceous, the lobes caespitose, compactly arranged, folded and contorted, confluent in spots and with only the tips free, brown when dry, pallid when soaked, gelatinous; hyphae with clamps, $1.5\text{--}5\ \mu$ in diam.; hymenium forming a distinct, pallisade-like, surface layer composed in part of sterile, thick-walled, vesiculose cells, $15\text{--}40 \times 12\text{--}30\ \mu$; probasidia obovate to pyriform or capitulate and briefly pedicellate, longitudinally or obliquely cruciate-septate, $12\text{--}21 \times 9.5\text{--}12\ \mu$; epibasidia and basidiospores not seen; conidiophores produced within the hymenium, the conidia borne in capitate masses, subglobose to subcylindric or more often irregular in shape, $3\text{--}9 \times 2\text{--}3\ \mu$.

The type specimen, no. 4017, was collected at Kobe, Japan, by J. E. A. Lewis.

TREMELLA MELLEA Lloyd, Myc. Writ. 5: 818. 1919, f. 1364.

Fig. 9

Foliaceous, the lobes folded, confluent, some hollow, gelatinous, pale yellow when soaked; in section, the lobes thin, consisting at first of a hyaline central portion with a layer of pale yellow conidiophores and conidia on either side; hyphae with clamps, about $1\text{--}3\ \mu$ in diam.; hymenium amphigenous, the basidia developing below the conidiophores; probasidia at first clavate, expanding at the apex and becoming capitate, usually retaining a stalk-like base, a few obovate, obliquely cruciate-septate, $10\text{--}21 \times 8\text{--}12\ \mu$ (including base), borne in clusters of 2–4 at the tips of delicate hyphae, proliferation occurring through the clamps and the basidia very close to one another; basidiospores not seen; conidiophores much-branched, of short cells separated by clamps, the conidia numerous, hyaline, globose to oval, $2.5\text{--}5 \times 1.5\text{--}3\ \mu$.

The species is known from a single specimen, no. 4008, collected by M. R. Espinosa, Santiago, Chile. As Lloyd pointed out, the specimen bears a resemblance to *Tremella mesenterica* Fries. Unfortunately, the specimen was immature when collected and only a few mature basidia and no basidiospores were found. While it seems to resemble some of the specimens referable to *T. mesenterica*, the stalked basidia distinguish it from specimens usually designated by that name.

TREMELLA MICROSPORA Lloyd, Myc. Writ. 6: 991. 1920, f. 1769.

Fig. 10

Foliaceous, the lobes 2–5 cm or more in diam., about 1 mm thick, gelatinous, brown when dry, avellaneous when soaked; hyphae $1.5\text{--}5\ \mu$ in diam., the larger ones with unevenly thickened walls giving the surface a conspicuous roughened appearance, clamps present but not abundant; hymenium forming a compact surface layer, amphigenous, about $30\text{--}40\ \mu$ thick, the hyphae bearing basidia terminally and proliferating laterally; probasidia pyriform to obovate or subglobose, width sometimes exceeding the length, the base truncate or tapering into a short stalk, becoming longitudinally to transversely cruciate-septate or the septa irregularly arranged, $(10\text{--})12\text{--}18\text{--}(23) \times 9\text{--}15\ \mu$;

epibasidia obsolete or present and up to $60 \times 1.5-3 \mu$; basidiospores ovate to subglobose, adaxially flattened, $6-8 \times 5-7.5 \mu$; subhymenial pockets of conidia present, the conidia mostly spherical, $2-4 \mu$ in diam.; basidia and epibasidia sometimes producing numerous blastospores rather than basidiospores.



FIG. 9. *Tremella mellea* Lloyd. a-d. Probasidia. e. Conidiophore bearing conidia.

FIG. 10. *Tremella microspora* Lloyd. a-c. Basidia and probasidia. d. Basidium producing blastospores. e. Basidiospores.

FIG. 11. *Tremella moriformis* (Fries) Berk. a. Mature basidium, one cell of which has already produced a spore. b-e. Basidiospores, one germinating by budding, another by repetition. f. Gemmae.

FIG. 12. *Tremella philippinensis* Lloyd. a, b. Basidia. c. Basidiospores.

The type specimen, no. 27046, was collected by A. V. Duthie, Stellenbasch, U. of So. Africa. As was stated by Lloyd, fructifications of this species bear a superficial resemblance to those of an *Auricularia*. Lloyd apparently mistook the conidia for basidiospores.

TREMELLA MORIFORMIS (Fries) Berk. Outl. Brit. Fung. 287. 1860.

Dacrymyces moriformis [Smith] Fries, Syst. Myc. 2: 229. 1822, based on *T. moriformis* Smith, in Sowerby, Engl. Bot. 34, pl. 2446. 1812.

Tremella colorata Peck, N. Y. State Mus. Ann. Rep. 25: 83. 1873.

Tremella ater-globosa Lloyd, Myc. Writ. 7: 1148. 1922, f. 22.

Fig. 11

Fructifications of gregarious pustules, these becoming confluent, then moriform, tough-gelatinous, dark reddish brown to almost black; in section, the interior reddish to purplish, the hymenium almost black; hyphae hyaline to brown or reddish, with clamps, the walls often becoming roughened with age, $1.5\text{--}4\ \mu$ in diam., a few inflated to as much as $10\ \mu$, bearing gemmae; gemmae subglobose to elliptic, thick-walled, $6\text{--}12 \times 5\text{--}7.5\ \mu$; hymenium amphigenous, the basidia mostly near the surface, a few deep in the interior; probasidia hyaline to brownish, globose to oval or obovate, becoming longitudinally to obliquely cruciate-septate, $(13\text{--})15\text{--}17(\text{--}26) \times 11\text{--}16\ \mu$; epibasidia up to $150 \times 1.5\text{--}6.5\ \mu$; basidiospores at first hyaline, becoming brownish, globose or more often broader than long, with the apiculus at right angles to the long axis, $7.5\text{--}11 \times 7\text{--}10\ \mu$.

Rick (Egatea 18: 347. 1933) suggested that perhaps *T. ater-globosa* Lloyd was not distinct from *T. moriformis* and there seem to be no significant differences between the type of Lloyd's species, no. 4007, collected by J. Rick, Brazil, and North American specimens of the latter.

This species is easily distinguished by its color and by the basidiospores which resemble those of *T. subanomala* Coker. The species is unique among tremellaceous fungi in that the pigment produced is of the indicator type, changing from dark red in acid solutions to deep blue in alkaline solutions. The pigment often diffuses outward and discolours the surrounding substratum.

TREMELLA PHILIPPINENSIS Lloyd (as *philippiensis*), Myc. Writ. 7: 7117. 1922, f. 2114.

Fig. 12

Fructifications cerebriform, gelatinous, amber when dry, soaking pale yellow; hyphae mostly $1.5\text{--}3.5\ \mu$ in diam., with clamps; hymenium forming an amphigenous subsurface layer, embedded as much as $75\ \mu$; probasidia subglobose to oval, becoming longitudinally cruciate-septate, $(15\text{--})20\text{--}25 \times (12\text{--})15\text{--}22.5\ \mu$; epibasidia up to $100 \times 3\text{--}7\ \mu$, swollen apically; basidiospores globose or subglobose, $10.5\text{--}12 \times 10.5\text{--}12\ \mu$.

The type specimen, no 3983, collected by S. Mariano, Mt. Maquiling, Philippine Islands, was probably immature and was either not properly dried or was partially decayed when collected. Sections of it did not stain well and little could be learned from them. The spore measurements given were taken from a rather small number of spores on the



FIG. 13. *Tremella roseo-tincta* Lloyd. a. Fertile hypha bearing probasidia and basidia in different stages of development. b, c. Mature basidia. d. Basidiospores, one germinating by repetition.

FIG. 14. *Tremella wrightii* Berk. & Curt. a. Fertile hypha showing arrangement of basidia. b, c, e. Probasidia. f. Basidiospores.

FIG. 15. *Tremella flavidula* Lloyd. a-c. Probasidia and basidia. d. Basidiospores, one germinating by repetition.

FIG. 16. *Tremella isabellina* Lloyd. a-c. Fertile hyphae bearing probasidia in various stages of development. d. Hypha bearing probasidia and conidiophore with conidia. e. Conidiophores and conidia.

hymenium and may not represent an accurate picture of the range. Two other specimens determined as this species by Lloyd, no. 29493, J. B. Cleland, Australia, and no 36437, L. Rodway, Tasmania, were examined. The Australian specimen is a *Calocera*: that from Tasmania, a *Dacrymyces*.

TREMELLA ROSEO-TINCTA Lloyd, Myc. Writ. 7: 1229. 1923, f. 2555.

Fig. 13

Foliaceous, the lobes several cm in extent, thin, caespitose, some fused along the margins, gelatinous, yellowish when soaked, drying rust-color; hyphae mostly $1.5\text{--}4\ \mu$ in diam., with numerous conspicuous clamps; hymenium amphigenous, forming a compact surface layer, the basidia borne terminally and lateral proliferation then occurring, often forming compact terminal clusters; probasidia oval to obovate, a few clavate or subspherical, longitudinally cruciate-septate or the septa irregularly arranged, $15\text{--}26\text{--}(33) \times 13\text{--}20\ \mu$; epibasidia mostly under $30\ \mu$ in length, $2.5\text{--}7\ \mu$ in diam., sometimes almost lacking; basidiospores ovate to subglobose, adaxially flattened, $10.5\text{--}13 \times 8\text{--}11.5\ \mu$, germinating by repetition and becoming distorted.

The type specimen, no. 3995, was collected in Japan by J. E. A. Lewis. Kobayasi (Tokyo Bunr. Diag. Sci. Rep. 4: 20. 1939) suggested that this might be no more than a form of *T. foliacea* Fries, but the size of the basidia and basidiospores and the color of the two suggest that they are distinct.

TREMELLA SAMOENSIS Lloyd. See *T. cinnabarina* (Mont.) Pat.

TREMELLA SPARASSOIDEA Lloyd, Myc. Writ. 6: 894. 1919, f. 1562.

The type specimen, no. 9860, was collected by M. S. Whetstone, Minneapolis, Minn. It does not appear to be distinct from *T. reticulata* (Berk.) Farl.

TREMELLA UNDULATA Hoffm. ex Schroet. Pilze Schles. 3(1): 396. 1888.

Reported by Lloyd from Brazil, Belgian Congo, and Johore. The specimen from Brazil, no 4022, J. Rick, is an *Auricularia*; that from Johore, no. 27044, G. A. Best, is *Sirobasidium magnum* Boed. The specimen from Belgian Congo, no. 4006, H. Vanderyst, is a *Tremella* and is probably best referred to *Tremella foliacea* Fries.

TREMELLA VINACEA Lloyd ex Stevenson & Cash. See *T. wrightii* Berk. & Curt.

TREMELLA WRIGHTII Berk. & Curt. Linn. Soc. Jour. Bot. 10: 341. 1868.

Tremella fucoides Möller, Protabas. 124. 1895.

Tremella vinacea Lloyd ex Stevenson & Cash, Bull. Lloyd Lib. (Myc. Ser. 8) 35: 37. 1936.

Fig. 14

Fructifications vesicular-lobate, the lobes spherical to elongate, branched or simple, inflated, caespitose, several cm in extent, gelatinous, fulvus to violaceous or almost black when dry, soaking ochraceous or brownish; in section, lobes hollow, the walls about $300\ \mu$ thick, the

hymenium forming a compact layer over the entire outer surface; hyphae with clamps, $2-4.5\ \mu$ in diam.; probasidia obovate or oval, a few approaching spherical, becoming longitudinally cruciate-sentate or the septa irregularly arranged, $12-26 \times 7-14\ \mu$, borne terminally and lateral proliferation of the hyphae occurring; epibasidia up to $60 \times 2-3\ \mu$; basidiospores ovate, flattened adaxially, $7-10 \times 5-6.5\ \mu$.

Lloyd did not give a description of this species when he published the name *T. vinacea* (Myc. Writ. 7: 1321. 1924), but his notes were later published by Stevenson and Cash. While I have not seen Möller's material, his description and illustration leave little doubt that his species is the same. The species is apparently very common in the American tropics and I have examined the following specimens of it: D. H. Linder, no. 146, Tumatumari, British Guiana and R. Thaxter, Port of Spain, Trinidad, in the herbarium of the New York Botanical Garden; J. Rick, São Canisio do Porto Nove, Brazil, G. W. Martin & A. L. Welden, no. 7978, Puerto Armuelles, Panamá, R. Singer, no. F 1486c, Miami, Florida, in the herbarium of the State University of Iowa; C. Torrend, Brazil, no. 3994 (type of *T. vinacea*); Wright, nos. 194 (type) and 529, Cuba, in the Royal Botanic Gardens, Kew.

ACKNOWLEDGMENT

This work was done in the laboratories of the New York Botanical Garden, the State University of Iowa, and the University of Illinois. I wish to express my appreciation to Mr. J. A. Stevenson, for making the specimens available to me, and to Dr. G. W. Martin and Dr. D. P. Rogers, for assistance given during the course of the study.

Notes on Fungi from Assam, III.

S. CHOWDHURY

(Plant Pathological Laboratory, Jorhat, Assam, India)

32. *UROMYCES DECORATUS* Syd. in Ann. Myc. 5: 491, 1907; Saccardo, Syll. Fung. 21: 549, 1912; Butler, *Fungi and Disease in Plants* : 373, 1918; Butler and Bisby, *Sci. Monogr. Counc. agric. Res. India*. 1: 81, 1931.

Pustules occur on the lower surface of the leaves and on the stems. Uredospores round to ellipsoidal, dilute brown with a spiny wall, 18 to 25 μ in diameter. Teleutospores chestnut brown, 21–28 x 14–21 μ , wall provided with large warts, stalk hyaline, very slender, easily detached from the spore.

On *Crotalaria juncea* L., Barbheta, 7.x.57, leg. S. Chowdhury. Specimen deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi. No. 25590.

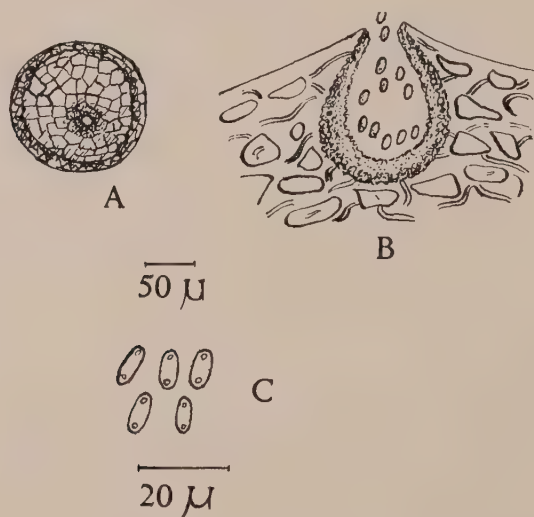


FIG. 1. *Phyllosticta elettariae* Chowdhury n. sp. A. Pycnidium viewed from above, B. Vertical section through pycnidium, C. Spores.

33. *Phyllosticta elettariae* sp. nov.

Fig. 1

Spots few to many on the upper side of the leaf, 0.5 to 7 mm. in diameter, adjacent spots sometimes coalesce and form larger spots, dirty white in color. Pycnidia globose, minute, subimmersed on the upper side of the leaf, brownish, usually scattered, rarely clustered together, ostiolate, 53–186 μ . Spores oblong, hyaline to sub-hyaline, guttulate, 7–11 x 3.5–4 μ .

On the living leaves of *Elettaria cardamomum* Mont., Nongpoh, 4.xi.57, leg. S. Chowdhury.

Type deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi. No. 25592.

Maculae rarae vel plurimae in pagina superiore foliorum, 0.5–7 mm. diam., adjacentes vero nonnumquam coalescentes ad efformandas maculas maiores, colore albido sordido. Pycnidia globosa, minuta, subimmersa in paginam superiorem foliorum, brunneola, ut plurimum dispersa, raro aggregata, ostiolata, 53–186 μ . Sporae oblongae, hyalinae vel subhyalinae, guttulate, 7–11 x 3.5–4 μ .

Typus lectus in foliis viventibus *Elettariae cardamomi* Mont., Nongpoh, die 4 novembris anni 1957 a S. Chowdhury et positus in *Herb. Crypt. Indiae. Orient.* I.A.R.I., New Delhi, sub numero 25592.

34. *Phyllostictina pratima* sp. nov.

Fig. 2

Spots on the upper side of the leaf, irregular, 0.5 to 10 mm. in diameter, often adjacent spots coalesce and form larger spots, at first brown in color, later become light brown or dirty white with an irregular brown border encircling the spot which gradually merges to

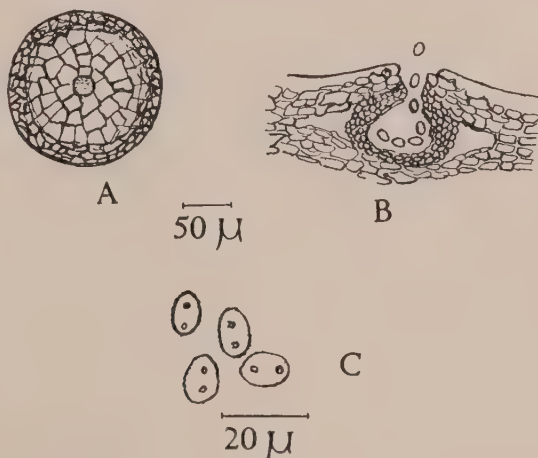


FIG. 2. *Phyllostictina pratima* Chowdhury n. sp. A. Pycnidium viewed from above. B. Vertical section through pycnidium. C. Spores.

the normal green of the leaf. In advanced stages the spots become pappery, split and the leaf tissue often fall off. Pycnidia innumerable, embedded on the spots, globose to sub-globose, developing sub-epidermally but later becoming erumpent, medium to dark brown in color, ostiolate, 98–144 μ . Spores globose, hyaline to subhyaline, 7–10 μ , guttulate.

On the living leaves of *Premna bengalensis* Clarke, Jorhat, 24.vii.57, leg. S. Chowdhury.

Type specimen deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi, No. 25591.

Maculae in pagina superiore foliorum, irregulares, 0.5–10 mm. diam., saepe adjacentes quidem maculae coalescunt ad efformandas maculas maiores, primo brunneae, tum pallide brunneae vel sordide albidae, marginibus irregularibus brunneis circumdantibus partem

mediam, quae gradatim transit in colorem viridem regularem foliorum. Proveniente aetate maculae evadunt papyraceae, rumpuntur atque textus foliorum decidere sinunt. Pycnidia plurima, immersa in maculas, globosa vel subglobosa, evoluta subepidermaliter sed postea erumpentia, simpliciter vel fusce brunnea, ostiolata, 98–144 μ . Sporae globosae, hyalinae vel subhyalinae, 7–10 μ , guttulae.

Typus lectus in foliis viventibus *Premnae bengalensis* Clke, ad Jorhat, die 24 julii anni 1957 a S. Chowdhury et positus in *Herb. Crypt. Indiae Orient.*, I.A.R.I., New Delhi sub numero 25591.

35. **Cerospora mandira** sp. nov.

Fig. 3

Spots on the upper side of the leaf, 2–5 mm. in diameter, adjacent spots rarely coalesce, at first dark brown in color, later the center of the spot becomes lighter in color with a darker border on all sides of the spot. Sometimes the center of the spot becomes brittle, splits and the leaf tissue may also fall off. Stroma 24 to 32 μ . Conidiophores

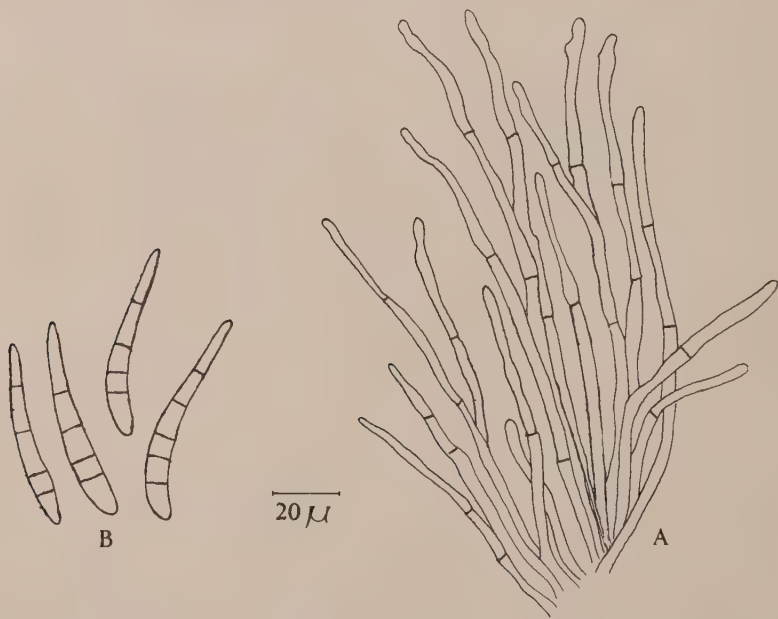


FIG. 3. *Cerospora mandira* Chowdhury n. sp. A. Conidiophore. B. Conidia.

arise in fascicles which are often very dense, almost coremoid, light brown in color, septate, often geniculate, 87–226 \times 3–4 μ . Conidia form on both sides of the leaf but more on the lower, cylindric-obclavate, sub-hyaline to light olivaceous, septate, straight or slightly curved, 35–80 \times 3.5–7 μ .

On the living leaves of *Tetrameles nudiflora* R. Br., Swarnapur, 3.ix.57, leg. S. Chowdhury.

Type specimen deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi. No. 25587.

Maculae in pagina superiore folii, 2–5 mm. diam., adjacentes maculae raro coalescentes, primo fusce brunneae, dein maculae evadunt pallidiores in medio, margine fuscior. Nonnumquam pars media maculae evadit fragilis, atque frangitur, et folii textus exciditur. Stroma 24–32 μ . Conidiophori surgunt fasciculati atque saepe densissimi, fere coremoidei, pallide brunnei, septati, geniculati, 87–266 x 3–4 μ . Conidia in utraque pagina folii producuntur, sed plura in inferiore pagina, cylindrico-obclavata, subhyalina vel pallide olivacea, septata, recta vel tenuiter curvata, 35–80 x 3.5–7 μ .

Typus lectus in foliis viventibus *Tretamelis nudiflorae* R. Br. ad Swarnapur, die 3 septembris anni 1957 a S. Chowdhury et positus in *Herb. Crypt. Indiae Orient.*, I.A.R.I., New Delhi, No. 25587.

36. *CERCOSPORA NIGRICANS* Cooke in *Grevillea* 12: 30, 1883; Chupp, *Monogr. Fungus Genus Cercospora* : 321, 1953.

Cercospora atro-maculans Ellis & Ev., *Jour. Mycol.* 3: 17, 1887.

Cercospora torae Tharp, *Mycologia* 9: 115, 1917.

Indefinite leaf spots at first appear on the upper surface of the leaves which later become grayish brown; fruiting occurs on corresponding lower leaf surface in sooty effuse patches, but rarely on both leaf surfaces. Conidiophores appear in fascicles, pale to medium olivaceous brown in color except at the tip where often it is lighter, upper portion undulate or mildly to abruptly geniculate, 38–98 x 3.5–5 μ . Stromata none or only a few cells. Conidia obclavate to obclavate-cylindric, sub-hyaline, straight or nearly so, 20–70 x 3.5–5 μ , medium to long obconic base, tip obtuse.

On *Cassia occidentalis* L., Barbheta, 8.x.57, leg. S. Chowdhury. Specimen deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi, No. 25588

37. *CERCOSPORA PLUMERIAE* Chupp in *Monogr. Fungus Genus Cercospora* : 49, 1953.

Leaf spots on the upper surface of the leaf, sub-circular to irregular, 1 to 12 mm. in diameter, often adjacent spots coalesce and form larger spots, olive brown when young and ashy gray with a thin brownish margin when mature. Fruiting both on the upper and the lower surfaces of the leaf but mostly on the upper surface. Conidiophores pale to medium brown, sub-hyaline and slightly attenuated toward the tip, geniculate, 25–75 x 3–5 μ . Conidia obclavato-cylindric, sub-hyaline to pale olivaceous, straight to mildly curved, tip subobtuse, 18–70 x 2–4 μ .

On *Plumeria acutifolia* Poiret, Swarnapur, 3.ix.57, leg. S. Chowdhury. Specimen deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi, No. 25589.

38. *Cercospora ranjita* sp. nov.

Fig. 4

Leaf spots lacking, fruiting in dark olivaceous patches on the lower leaf surface, 0.5 to 5 mm. in extent, often larger patches may be seen due to coalescence of adjacent patches. Stromata lacking. Conidiophores borne as branches from procumbent threads, light to medium brown, almost uniform in color and width, plainly multiseptate, not

or slightly geniculate, bluntly rounded tip, straight to variously curved, $37-176 \times 3.5-5.5 \mu$ or even more in length. Conidia pale olivaceous, cylindric to obclavate-cylindric, mostly 2 to 6 septate, straight to slightly curved, $26-94 \times 3.5-6 \mu$.

On the living leaves of *Gmelina arborea* Linn., Lahing, 28.x.57, leg. S. Chowdhury.

Type deposited in the *Herb. Crypt. Indiae Orient.*, Indian Agricultural Research Institute, New Delhi, No. 25586.

Maculae foliorum nullae; fructificationes in areis olivaceis in inferiore pagina foliorum, 0.5-5 mm. diam., saepe areae majores ob coalescentiam areolarum adjacentium evadunt. Stromata nulla. Conidiophori insidentes ramulis ex filamentis procumbentibus, pallide vel sat brunnei, fere uniformes colore et latitudine, plane multiseptati, aut nullo modo aut tantum tenuiter geniculati, apice rotundato, recti vel varie curvati,

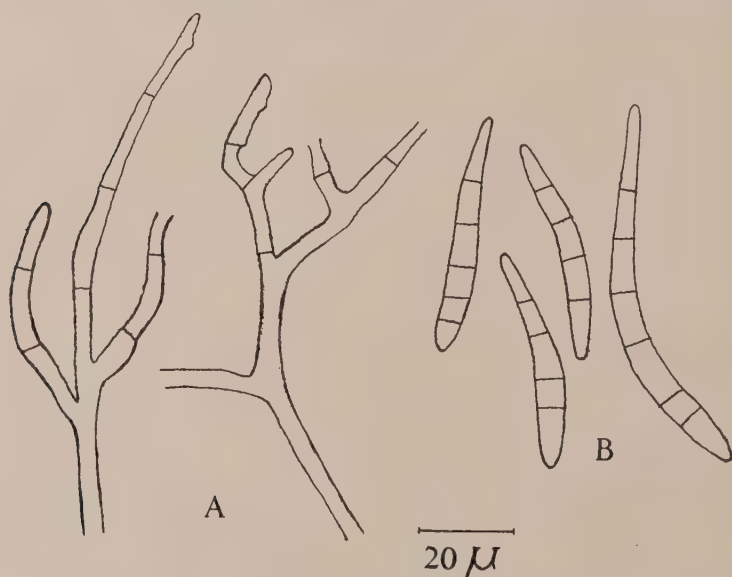


FIG. 4. *Cercospora ranjita* Chowdhury n. sp. A. Conidiophore. B. Conidia.

$37-176 \times 3.5-5.5 \mu$ vel longiores. Conidia pallide olivacea, cylindrica vel obclavato-cylindrica, ut plurimum 2-6 septata, recta vel parum curvata, $26-94 \times 3.5-6 \mu$.

Typus lectus in foliis viventibus *Gmelinae arboreae* Linn. ad Lahing, die 29 octobris anni 1957 a S. Chowdhury et positus in *Herb. Crypt. Indiae Orient.*, I.A.R.I., New Delhi sub numero 25586.

ACKNOWLEDGEMENT

The author's thanks are due to Rev. Father Dr. H. Santapau, St. Xavier's College, Bombay for the preparation of the Latin diagnoses of the new species and Director, Commonwealth Mycological Institute, Kew for help rendered in identification.

Revision of the Genus *Erianthus* Michx. (Gramineae)

SUNIL KUMAR MUKHERJEE
(Writers' Buildings, Calcutta 1, India)

HISTORY

The genus *Erianthus* was established by Michaux in *Flora Boreali-Americana* in 1803 with two species, *E. saccharoides* and *E. brevibarbis*. Roxburgh (1820) did not recognize *Erianthus*. Of his 11 species of *Saccharum*, 4 have been transferred to *Erianthus* (one in the present revision), one to *Imperata*, one to *Sclerostachya*. Steudel (1855) also did not recognize *Erianthus* as a distinct genus. Of the 62 species described under *Saccharum*, 19 belong to *Erianthus*. Since 1803 many species of *Erianthus* have been proposed and Hackel in his revision of *Andropogoneae* (1889) recognized 19 species as valid, and one as a "species dubia". Hooker (1896) kept *Erianthus* distinct from *Saccharum* but remarked that he found "no characters whereby to separate *Erianthus* from *Saccharum*", except the awned glume IV in the former. Bor (1940) recognized 4 genera, *Saccharum*, *Erianthus*, *Sclerostachya*, and *Narenga*, all of which were previously included in the genus *Saccharum*. Jansen in *Flora Malesiana* accepted the separation of *Erianthus* from *Saccharum*.

It is therefore evident that taxonomists differ in regard to the separate status of *Erianthus*. But sugarcane technologists like Jeswiet (1925) and Artschwager (1948) who studied the plants under living conditions, and not from dried herbarium specimens, provided strong arguments in favor of keeping *Erianthus* separate from *Saccharum*. This view was recently given support by Dutt and Rao (1950), of the Coimbatore Sugar Cane Breeding Institute, by listing the distinguishing features of the genera *Saccharum*, *Erianthus*, *Sclerostachya*, and *Narenga* in tabular form, following a study of the morphological and anatomical features of these species under living conditions. On examination of the herbarium specimens and living plants under natural conditions (Mukherjee, 1949), I am also of the opinion that these genera should be kept separate. The distinctive features of the genus are given below under "range of characters".

A revision of the genus was undertaken because its position is uncertain and no more recent treatment is available since that of Hackel (1889), in which he recognized only 20 species. But the number of valid species recorded in *Index Kewensis* is 44. This revision is based on examination of Indian specimens from the Calcutta Herbarium (CAL) and of American specimens from the Herbarium of the New York Botanical Garden (NY), received on loan.*

RANGE OF CHARACTERS IN THE GENUS

Most of the plants are large tufted grasses forming clumps. In some species, the growth of the culms is biennial, and therefore both

*The abbreviations inside parentheses indicate the herbaria mentioned in the text.

vegetative and reproductive culms occur together, e.g., *E. arundinaceus*. Most of the species, however, bear only flowering culms. The culms of *Erianthus* are quite different from those of *Saccharum*, e.g., (1) the pith does not contain sugar as in *Saccharum*, (2) polished internodes without much waxy secretion, (3) narrow growth-ring, (4) narrow root-zone with one row of root eyes only, which may sometimes be very poorly developed, and (5) elongated buds with very narrow wings. *Erianthus arundinaceus* and *E. procerus* form well-developed shoots which look very much like those of sugarcane, whereas most of the species of *Erianthus*, particularly the Himalayan ones, produce tufted plants with shorter culms.

The leaves also vary in size in the different species, and have hairy or glabrous leaf-sheaths. One characteristic feature of *Erianthus* leaves is the absence of "dewlaps" and "auricle" and the presence of a narrow arcuate ligule (Fig. 1) and of dense hairs along the midrib just above the ligule, which distinguish them at once from any *Saccharum* leaves. The blades may be very narrow, as in *E. filifolius*, or as broad as sugarcane leaves, as in *E. arundinaceus*.

Most important variations of taxonomic significance occur in the inflorescence. The panicle is elongated (90 cm. or more) and spreading, with the basal branches almost as long as the main axis in *E. procerus*, a character more common in *Saccharum*. At the other extreme are the species with short, clubshaped, narrow inflorescences as in *E. fulvus*, *E. strictus*, etc. Intermediate are the species with slightly more spreading branches and longer inflorescences such as *E. Munja*, *E. Ravennae*, etc. Pubescence on the main axis below the inflorescence supplies characters of practical value for identification. These are present in a number of species whereas in others they are completely absent. Callus hairs at the base of spikelets, which are in pairs, one of which is pedicellate and the other sessile, vary appreciably in size and coloration. These are much longer than the spikelets, or as long as the spikelets in most species, but in a few of the American species (e.g., *E. strictus* and *E. brevibarbis*) and in the European *E. hostii*, they are very short or almost absent. Each spikelet consists of four glumes, of which the outer two, i.e. glumes I & II, are usually furnished with long hairs on the back, overtopping the spikelets (Figure 1). This is a characteristic feature but in a few species, e.g., *E. fulvus*, *E. longisetosus*, and *E. Perrieri*, glumes I and II are almost glabrous dorsally, which is a feature of *Saccharum*. The most important differentiation from *Saccharum*, according to Hooker and others, is the presence of an awn on glume IV (the lemma) (Fig. 1). The awn may be straight or twisted, long or short, exserted or included. An included short awn is characteristic of *E. arundinaceus*; *E. Griffithii*, and *E. Munja*. Perhaps for this reason they were included by previous workers like Hackel and others under *Saccharum*, but other characters suggest their inclusion under *Erianthus*, as discussed under the individual species. The spikelets also vary in size in different species, and are aggregated densely or loosely which means that the rhachis-joints and pedicels are short or long.

Thus variation in the genus affects the growth form of the plants, size and branching of the panicle, nature of callus hairs and glumes, and length of the awn.

DISTRIBUTION OF THE SPECIES

The natural area of distribution of the species is given in Fig. 2 and in Table 1. The table shows that most species occur in Asia and especially in India in the Himalayas and foothills. The other center of distribution lies in the New World. *E. Ravennae* is widespread in cultivation and is distributed from India to Europe, particularly in the Mediterranean region. In the East *E. maximus* is distributed in the Polynesian islands of the Pacific. One peculiar feature of phytogeo-

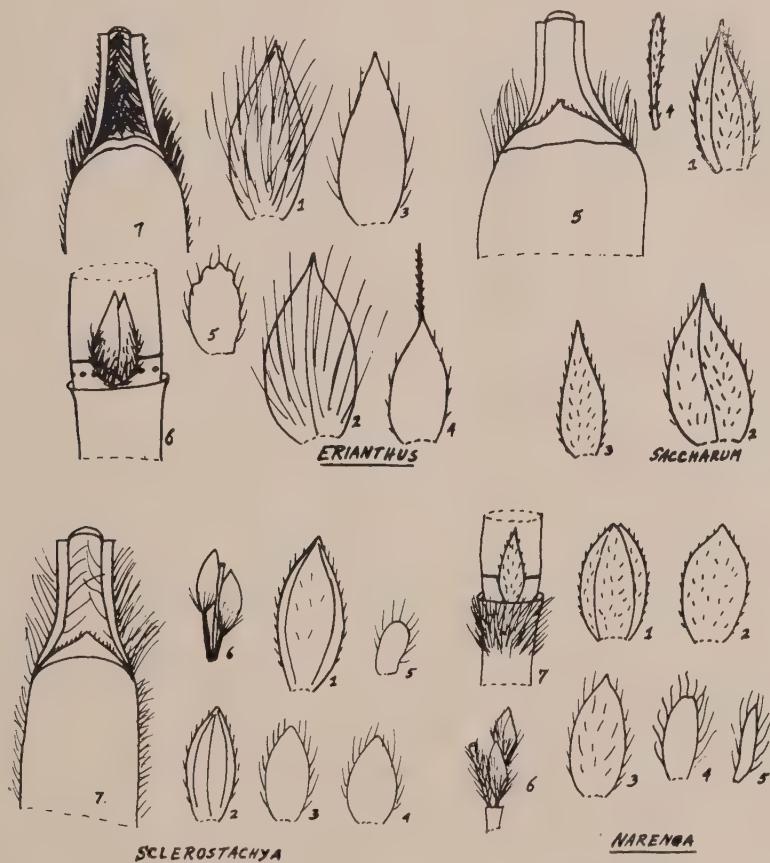


FIG. 1.—Representative drawings of the floral, leaf, and stem parts of the genera *Erianthus*, *Saccharum*, *Sclerostachya* and *Narenga*. *Erianthus*—1-4 represents glumes I-IV, 5—palea, 6—a node with bud and root-zone, 7—leaf sheath with blade joint showing narrow arcuate ligule. *Saccharum*—1-4 represents glumes I-IV, 5—leafsheath with bladejoint showing triangular ligule. *Sclerostachya*—1-4 represents glumes I-IV, 5—palea, 6—one pair of spikelets (both pedicellate), 7—leaf sheath with bladejoint showing ligule. *Narenga*—1-4 represents glumes I-IV, 5—palea, 6—one pair of spikelets; 7—a piece of stem showing bearded node, rootzone, and bud. Note the distinguishing features of *Erianthus* (1) node with one row of root eyes; (2) leafsheath with arcuate ligule and densely fulvous blade; (3) glumes I and II with long dorsal hairs; (4) glume IV much more developed and with characteristic awn.

graphical interest is this discontinuous distribution with two centers, one in India and one in America. *Erianthus* is not included in the list given by Good (1947).

ERIANTHUS Michx. Fl. Bor. Am. 1: 54, 1803; Kunth, Revis. Gram. 1: 160, 1829; Enum. 1: 478, 1833; Anderson Ofv. Svensk Vet. Akad. Forh. 12: 160, 1855; Benth. et Hook. Gen. Pl. 3: 1126, 1883; Hackel

TABLE 1.—Geographical distribution of the species of *Erianthus*.

[illegible]

in DC. Monog. Phan. 6: 128–151, 1889; Hook. Fl. Brit. India 7: 121–126, 1896; Jeswiet in Suikerind. Nederl. Indie, 33: 399, 1925; Hitchcock, Man. Grasses U.S. 721, 1935; ed. 2: 743, 1951. Bor, Flora Assam, 5: 322–327, 1940; Artschwager, U.S.D.A. Tech. Bull. 951, 1948.

Type species: *E. saccharoides* Michx.

Perennial grasses forming well defined tufts. Culms erect, robust; usually 1–2 m. tall, in some attaining even 6 m. in length and 2.5 cm. in thickness; commonly biennial in growth habit; internodes long, with a “root zone” at nodes, root eyes usually in one row and not developing, buds generally scaly and elongated, not capable of development, appressed hairy or glabrous and shiny below the panicles. *Lamina* linear lanceolate; varying greatly in size, usually 5–2 m. in length, in width from very narrow and reduced to midrib to types as broad as in sugarcane (2–3 cm.); leaf sheath long, hairy or glabrous; ligule narrow,



FIG. 2.—Map showing the areas of distribution of the four genera: *Erianthus* (---), *Saccharum* (—), *Sclerostachya* (...) and *Narenga* (| | |).

with characteristic horseshoe shaped appearance; dewlap and auricle wanting; midrib of lamina prominently hairy above bladejoint. *Panicle* varying, 10–90 cm. or more in length; pyramidal with spreading branches at blade as long as the main axis to clubshaped or narrow, densely or laxly flowered; rhachis joints and pedicels varying in length, usually densely hairy, rarely almost glabrous; *spikelets* in pairs, one sessile and the other pedicelled, both hermaphrodite, usually 4–6 mm. long; callus hairs commonly present and longer or as long as the spikelet, rarely absent or shorter than the spikelet; glumes 4, I & II equal, membranous to coriaceous, usually dorsally villous with long hairs; III hyaline, shorter, with usually one median nerve; IV narrow, ovate-lanceolate, hyaline, with usually a prominent straight or twisted exserted awn 4–20 mm. long; lodicules 2, cuneate; stamens 2–3; stigmas 2, feathery. *Caryopsis* oblong to linear-oblong.

KEY TO THE SPECIES OF ERIANTHUS

1. Culm pubescent or appressed-hairy below the panicle.
 2. Panicle elongated, 30-90 cm. or more in length with branches spreading.
 3. Panicle laxly branched and laxly flowered; rhachis joints 6-8 mm. long; lamina narrow, 6-12 mm. wide; leaf sheath densely hairy..... 1. *E. laxus* Nash
 3. Panicle densely branched with closely aggregated spikelets; rhachis joints 2.5-3 mm. long; lamina broad, about 2 cm. wide; leaf sheath glabrous..... 2. *E. Tracyi* Nash
 2. Panicle short, usually less than 30 cm. (sometimes up to 40 cm. in *E. asper* and *E. Trinii*).
 4. Panicle narrow, clubshaped, with short secondary branches (3-4 cm.).
 5. Callus hairs very dense, more than twice the length of short spikelets (2.5-3 mm.); glumes I and II dorsally glabrous..... 3. *E. rufipilus* (Steud.) Griseb.
 5. Callus hairs slightly longer than big spikelets (5-7 mm.); glumes I and II dorsally villous.
 6. Panicle very short (10-15 mm.); tawny to purplish; spikelets about 5 mm. long..... 4. *E. giganteus* (Walt.) Muhl.
 6. Panicle longer (20-40 cm.), silky white; spikelets 5-7 mm. long..... 5. *E. Trinii* Hackel.
 4. Panicle broad, with spreading secondary branches.
 7. Awn twisted.
 8. Lamina broad (1-2.5 cm.); panicle 20-30 cm. long; spikelets 5-6 mm. long..... 6. *E. alopecuroides* (L.) Ell.
 8. Lamina narrow (6-8 mm.); panicle about 18 cm. long; spikelets 7-8 mm. long.
 9. Callus hairs about one third shorter than spikelet, awn 10-11 mm. long..... 7. *E. Viguierei* A. Camus
 9. Callus hairs as long as spikelets; awn 15-20 mm. long..... 8. *E. Balansae* Hackel.
 7. Awn straight.
 10. Glumes I and II dorsally glabrous; awn about 8 mm. long; leaf sheath glabrous.... 9. *E. asper* Nees.
 10. Glumes I and II dorsally villous; awn 10-20 mm. long; leaf sheath hairy.... 10. *E. saccharoides* Michx.
 1. Culm glabrous below the panicle (except in *E. filifolius*, *E. Hostii*, *E. sumatranus*, *E. Hookeri* and *E. Beccarii* which have occasionally slightly pubescent axis).
 11. Panicle narrow, contracted, with short secondary branches; callus hairs few or wanting.
 12. Callus hairs few and short or absent; panicle nearly completely glabrous; awn straight..... 11. *E. strictus* Baldw.
 12. Callus hairs developed.
 13. Callus hairs scanty, much shorter than spikelets.
 14. Awn very short, 2-6 mm. long..... 12. *E. Hostii* Griseb.
 14. Awn long, about 2 cm., straight..... 13. *E. brevibarbis* Michx.
 13. Callus hairs as long as or longer than spikelet; awn 2 cm. long, coiled..... 14. *E. contortus* Baldw.
 11. Panicle broad with spreading basal branches; callus hairs usually prominent.
 14. Panicle 30 cm. or less in length.
 15. Awn included about 1.5 mm. long; callus hairs shorter than the spikelets; lamina narrow, about 8 mm. wide..... 15. *E. Griffithii* (Hask.) Hook. f.
 15. Awn exserted, long.

16. Lamina narrow, almost reduced to midrib throughout.....
16. *E. filifolius* Nees ex Steud.
 16. Lamina flat, broad, 1-3 cm. wide.
17. Glume I dorsally villous; callus hairs whitish.....
17. *E. Hookeri* Hack
 17. Glume I dorsally glabrous or slightly pubescent.
18. Awn very long (about 2 cm.); rhachis joints 8-10 mm. long;
pedicels 5-6 mm. long.....18. *E. longisetosus* Anderss.
 18. Awn shorter, 9-10 mm. long; rhachis joints 2-4 mm. long;
pedicels 2-4 mm. long.
19. Spikelets 3-3.5 mm. long in coppery purple panicle;
lamina short and broad (18-30 cm. x 2-3.5 cm.).....
19. *E. Beccari* (Stapf) Jansen.
 19. Spikelets 4.5-5 mm. long in yellowish white panicle;
lamina longer and narrower (80 cm. x 1 cm.).....
20. *E. Perrieri* A. Camus.
 14. Panicle usually 30-90 cm. in length.
 20. Panicle effuse, spreading, with lower branches almost
as long as the main axis.
21. Spikelets laxly arranged; rhachis joints 6-7 mm.
long.
22. Leaves narrow (4-5 mm.); awn short, ex-
serted; glume I dorsally villous.....
21. *E. trichophyllus* Hand.-Mazz.
 22. Leaves broad (1-5 cm. wide).
23. Callus hairs almost as long as spikelet;
awn 1 mm. or less, included; glume I
dorsally villous.....
22. *E. procerus* (Roxb.) Raizada.
 23. Callus hairs much shorter than spikelet;
awn 2-4 mm.; exserted; glume I dorsally
glabrous.....23. *E. maximus* Brongn.
 21. Spikelets closely aggregated; rhachis joints 1.5-2
mm. long; glumes tipped pink.....
24. *E. elephantinus* Hook. f.
 20. Panicle less spreading with secondary branches much
shorter than the main axis.
24. Culms biennial, usually attaining
0.2 m. in one year; lamina broad,
about 5 cm. or more wide; awn very
short .03-.05 mm., included.....
25. *E. arundinaceus* (Retz.) Jeswiet.
 24. Culms biennial, mature basal por-
tion not exceeding 5 cm. in one year;
lamina narrower, less than 2.5 cm.
wide; awn longer.
25. Awn exserted, 2-6 mm. long.
26. Glume II dorsally villous;
callus hairs shorter than
spikelets.....
26. *E. Ravennae* (L.) Beauv.
 26. Glume II without long hairs
on the back; callus hairs twice
as long as spikelets.....
27. *E. parviflorus* Pilger
 25. Awn inconspicuous, included;
glume II of sessile spikelets dor-
sally glabrous; callus hairs
slightly longer than spikelets....
28. *E. Munja* (Roxb.) Jesw.
1. Culm pubescent or appressed hairy below the panicle.
 2. Panicle elongated, 30-90 cm. long, spreading.

1. *ERIANTHUS LAXUS* Nash, Bull. Torr. Bot. Club 24: 344, 1897—under *E. giganteus* (Walt.) Muhl. in Hitchcock, Man. Grasses U.S. 727, 1935.

Culms erect, stout, 2–3 m. tall, hairy around nodes and below the panicle. *Lamina* flat, 20–50 cm. long, 6–12 mm. wide, hirsute on both surfaces; leaf sheath densely hairy. *Panicle* 40–50 cm. long, with secondary branches 8–20 cm. long, laxly branched and flowered; rhachis joint about 6–8 mm. long; pedicels about 2–2.5 mm. long. *Spikelets* 4–5 mm. long, lax, half as long as the callus hairs, glumes I and II dorsally villous with long hairs; awn straight, about 2 cm. long.

In establishing the species Nash remarked that “the elongated branches of the panicle, the long internodes of the rachis, and the longer basal hairs of the spikelet distinguish this at once from any form of *E. saccharoides*, to which it is related”. On examination of the type sheet, I find it to be quite distinct from others in its panicle. I have therefore kept it separate, although Hitchcock reduced it to *E. giganteus*.

Sheets examined—U.S.A.: FLORIDA: Lake county, Eustis, wet hammock between Paola and the Wekiva River, W. T. Swingle 1732, 22 August 1894 (Type from N.Y.).

Distribution—U.S.A.: Florida.

2. *ERIANTHUS TRACYI* Nash, Bull. Torr. Bot. Club, 24: 37, 1897—under *E. giganteus* (Walt.) Muhl. in Hitchcock, Man. Grasses U.S. 723, 1935.

A tall, robust plant. *Culms* about 2.7–3 m. tall, 1 cm. in diam.; hairy below the panicle. *Lamina* about 40–50 cm. long and 2 cm. broad; leaf sheath almost glabrous except at blade joint. *Panicle* about 40–50 cm. long, densely branched; secondary branches about 5–7 cm. long; rhachis joints 2.5–3 mm. long; pedicels about 2 mm. *Spikelets* 5–6 mm. long, closely aggregated; callus hairs very dense, overtopping the spikelets (about 1 cm.); glumes I and II dorsally villous; awn about 2 cm. long, straight.

It is distinct from others in its robust plant with broad flat lamina, the conspicuous very densely flowered panicle, and in the dense callus hairs, much longer than the spikelets. It should therefore be kept separate and not merged with *E. giganteus* as suggested by Hitchcock.

Sheets examined—U.S.A.: MISSISSIPPI: Starkville, 1896, S. M. Tracy (Type); Oktibbeha Co., Agric. College, 11–17 Aug. 1896, C. L. Pollard 1341. MISSOURI: Newtonia, 28 May 1879, D. L. Phares ex Herb. Tracy (NY).

Flowering—Usually during May to August.

Distribution—U.S.A.: Missouri, Mississippi.

2. Panicle short, usually less than 30 cm. long.

4. Panicle narrow, club shaped.

3. *ERIANTHUS RUFIPILUS* (Steud.) Griseb. Nachr. Ges. Wiss. Göttingen, 92, 1868; Duthie, Grasses N.W. India, 15. *Saccharum rufipilum* Steud. Syn. Pl. Glum. 1: 409, 1855. *E. fulvus* Nees ex Steud. ex Hack. in DC. Monog. Phan. 6: 147, 1889; Hook. f., Fl. Brit. Ind. 7: 123, 1896; Bor, Fl. Assam, 5: 323, 1940 (fig. 3).

Lamina narrow linear, 30–70 cm. long, 8–16 mm. wide; leaf sheath glabrous except at top. *Panicle* erect, silky whitish or purplish,

20-25 cm. long; very densely flowered, clubshaped, with only short secondary branches up to 6 cm. long. *Spikelets* crowded, 2.5-3 mm. long; pedicels and rhachis joints 2 mm. long; callus hairs 1 cm. long; glumes I and II dorsally glabrous; awn about 1 cm. long, straight.

A very distinct species for its narrow clubshaped inflorescence. Quite common in E. Himalayas.



FIG. 3.—Photograph of *Erianthus rufipilus* (Steud.) Griseb.

Type—*Saccharum rufipilum* Steudel.

Sheets examined—INDIA: W. HIMALAYAS: Hazara, Deoli, 25 Aug. 1899, Inayat; Kazim Valley (8000 ft.) 24 July 1899, Inayat 20321, 28 Aug. 1896, Inayat 20322; Rebba (7500 ft.) 27 Aug. 1890, Herb. Lace 583; Dalhousie (5000 ft.) 20 Sept. 1874, Clarke 22777D; Bugm Valley (9000 ft.) Sept. 1864, Brandis 307 F; Kullu Valley, Nirmand

(5000 ft.) 30 Sept. 1894; Kumaon, Naini Tal (7500 ft.) Strachey and Winterbottom 2/12; Simla, Gowai (6000 ft.) 20 Sept. 1877, Gamble 500; Thomson ex Herb. Ind. Or. NEPAL: Wallich. E. HIMALAYAS, SIKKIM (5-7000 ft.) Hooker; Darjeeling, above Lebong, 23 Sept. 1859, S. Kurz. ASSAM: Khasi Hills, Mawflong, Griffith; Assam Deputation Collection 1835, Markadokadok (5000 ft.) 13 Sept. 1885, Clarke 40386; Kala Pani (5000 ft.) 17 Oct. 1872, Clarke 19032; Hooker and Thompson ex Herb. Ind. Or.; Cherrapunji, July 1878, Gallatly 466; Cherra Road (6000 ft.) 8 Oct. 1914, U. N. Kanjilal 4487 (vern. Meo); *E. rufipilus* ex Herb. Griffith; Naga Hills, Chedama, Sept. 1886, Prain. CHINA: Hupeh, 1885-88, Dr. Henry 5115; Yunnan, 1897, Henry 9818 (CAL). Yunnan, Cong-Cohonan, 1910, G. Bonati 6999; Mountains above Tseku and Tsachchung, Mekong-Salween Watershead, 1923, J. F. Rock 11609 (NY).

Flowering—September to December.

Distribution—India: Common in Himalayas, particularly eastern Himalaya; Assam; Nepal; China-Yunnan.

4. *ERIANTHUS GIGANTEUS* (Walt.) Muhl. Cat., Pl. 4. 1813; Hitchcock, Man. Grasses U.S. 723, 1935. *Anthoxanthum giganteum* Walt., Fl. Carol. 65, 1788. *Saccharum giganteum* (Walt.) Pers., Syn. Pl. 1: 103, 1805. *Saccharum erianthoides* Raspail, Ann. Sci. Nat., Bot., 5: 308. 1825. *Erianthus compactus* Nash, Bull. Torr. Bot. Club 22: 419, 1895.

Culms 1-3 m. tall, appressed-villous below the panicle, nodes bearded. Sheaths and blades from nearly glabrous to shaggy appressed villous. *Lamina* 30-40 cm. long, and 4-10 mm. wide; ligule membranous, 4-5 mm. long. *Panicle* short, 10-15 cm. long, with 3-4 cm. long secondary branches, clubshaped, tawny to purplish, densely villous, bearing spikelets from the base. *Spikelets* about 5 mm. long; callus hairs slightly longer than spikelets; awn about 1-1.5 cm. long, terete, straight; rachis joint and pedicel about 3 mm. long, pilose; glumes I and II dorsally villous and with long hairs.

Hitchcock (1935) reduced *E. compactus* Nash, *E. laxus* Nash, *E. Tracyi* Nash and *E. saccharoides* Michx. to the single species *E. giganteus*, and remarked that *E. giganteus* is very variable, showing varying forms like *E. compactus*, *E. Tracyi*, and *E. laxus*. On examination of the types of the four species from the N. Y. Bot. Gard. Herbarium I regard the variations to be such (in consideration of the general range of variation in the genus) that 4 different species should be recognized. *E. saccharoides* has some forms approaching *E. laxus* and *E. Tracyi*. Only *E. compactus* should be reduced to *E. giganteus*, both of which possess characteristic short, compact panicles, 10-15 cm. long. *E. laxus* and *E. Tracyi* are to be maintained as separate species on account of distinct panicles.

Type—Based on *Anthoxanthum giganteum* Walt.

Sheets examined—U.S.A.: DISTRICT OF COLUMBIA: Brightwood, open swampy ground, 7 Oct. 1905, Hitchcock, Amer. Gr. Nat. Herb. No. 235 (described as *E. compactus* Nash). Washington 15 Sept. 1895, G. V. Nash (Type of *E. compactus*) (N.Y.). PENNSYLVANIA: Hammonton, 9-7-92, J. Bernard Brinton (CAL). VIRGINIA: Fairfax Co., near

Fairfax, 21 Sept. 1936, H. A. Allard 2303; Fairfax Co., low field on U.S. Highway 50, 22 Sept. 1938, F. J. Hermann 9813; Southern Appalachian Expedition, 10 Sept. 1933. N. CAROLINA: near Franklin, Mexander, Everett and Pearson. S. CAROLINA: Georgetown Co., Swale, 11 Sept. 1939, R. K. Godfrey 8192.

Flowering—Sept. to October.

Distribution—U.S.A., District of Columbia, Pennsylvania, Virginia and Carolina.

5. *ERIANTHUS TRINII* Hack. in DC. Monog. Phan. 6: 135, 1889. *Saccharum giganteum* Pers. in Trin. Mem. Acad. Petersb., Ser. 6, 2: 311, 1832. *Erianthus saccharoides* β *Trinii* Hack. in Mart. and Eichl. Fl. Bras. 2: pt. 3, 258, 1883.

Culm 2–3 m. tall, thin, pubescent below panicle. *Lamina* narrow, 1 m. long, 5–2 cm. wide; sheath hairy or glabrous. *Panicle* 20–40 cm. long, silky white or cream colored, laxly branched; secondary branches 4–5 cm. long, at a distance of 4–6 cm; axis densely hairy. *Spikelets* 5–7 mm. long; rhachis joint, 4–6 mm. long; pedicel 3–5 mm. long; callus hairs dense, slightly longer than spikelet; glumes I and II dorsally villous with long hairs; awn 8–12 mm. long, straight; anthers 0.8 mm. long.

This is allied to *E. saccharoides* but differs in the laxly branched panicle, with longer rhachis joint and pedicels and with callus hairs longer than spikelets as in *E. laxus* and *E. tracyi*.

Sheets examined—MEXICO: Mirador, Oct. 1841, Liebman 39 (type for sub.—var. *glabrinodis* Hack.) Nuevo Leon, Sierra Madre, 27.8.1889, Pringle 2619; Borrego, Orizaba, 1865–66, Bourgeau 2970; Orizaba, Aug. 1853, F. Muller 2033; San Louis Potosi, Tamasopo Canyon, mountain sides, 24–6–1890, C. G. Pringle 3135. PARAGUAY: Pedro Jorgensen 4090. BRAZIL: Perrinha 1.2.1912, P. Dusen; Rio de Janeiro, Leme, 1910, Lutzburg 9; Leblon, near Lagoa de Freitas, 13–14 Jan. 1925, Steep open cliff, Agnes Chase 8228; Reidel 996 ex Herb. Petropolitani (cited as var. *glabrinodis* Hackel). S. Paulo, Gerdes 58 ex Hb. Hackel. COLOMBIA: Cauca State, Tierra Adentro, R. Palo Basin (2000 m.), Feb. 1906 H. Pittier 1471; El Cauca, El Ramal to Rio Sucio, Popayan, Prairie (1600–1900 m.), 3.7.1922, F. W. Pennel and E. P. Killip 8137; Antioquia, Puerto Berrio (130–140 m.), swamp, 11–13 Jan. 1918, F. W. Pennell 3726 (NY).

Distribution—Mexico, Brazil, Paraguay, Uruguay, and Colombia.

6. *ERIANTHUS ALOPECUROIDES* (L) Ell., Bot. S.C. and Ga. 1: 38 (1816); Silveus, Texas Grasses, 706, 1933; Hitchcock, Man. Grasses U. S. 722, 1935. *Andropogon divaricatus* L. Sp. Pl. 1045, 1753. *Andropogon alopecuroides* L. Sp. Pl. 1045, 1753. *Saccharum alopecuroides* Nutt. Gen Pl. 1: 60, 1818. *E. divaricatus* Hitchcock, Contr. U. S. Nat. Herb. 12: 125, 1908.

Culm robust, 1.5–3.0 m. tall, appressed villous below the panicle; nodes densely bearded as in *Narenga*. *Lamina* 20–50 cm. long, 1–2.5 cm. broad; leaf sheath almost glabrous. *Panicle* 20–30 cm. long, silvery to tawny or purple, contracted and narrow; secondary branches 3–6 cm. long. *Spikelets* 5–6 mm. long; callus hairs as long as spikelet or slightly longer; rhachis joint 5 mm. long; pedicel 3–4 mm. long;

glumes I and II dorsally villous with long hairs, awn about 1.5 cm. long, flat, spirally coiled at base.

Type—based on *Andropogon alopecuroides* of Linnaeus.

Sheets examined—U.S.A.: MISSOURI: Barry Co.: Eagle Rock, Sept. 20, 1896, B. F. Bush 382; 30 Sept. 1896, K. K. Mackenzie, monteer, high rocky woods, 5 Oct. 1905, B. F. Bush 3524, Oct. 9, 1910, Bush 6402, 6402 a. Christian Co., high rocky hills, Sept. 21, 1905, Bush 3337, Dunklin, Sept. 14, 1893, Bush 160. ARKANSAS: Jefferson County, Watson State Park, Pine Bluff (200 ft.), moist open pine ridges, 10 Jan. 1942, Demaree 24038. Yell Co., Mt. Nebo State Park, Dardanelle (1500 ft.), 30 Aug. 1939, D. Demaree 20545 A (NY). DISTRICT OF COLUMBIA: G. McCarthy (CAL). NORTH CAROLINA: Winston-Salem, Forsyth County, open fields, 14 Sept. 1941, ex herb. P. O. Schallert; Chioi mountain, Sept. 1842, Rugel ex Torrey Herb. Lincolnton, Curtis 1835. SOUTH CAROLINA: Orangeburg Co., 13 Sept. 1939, R. K. Godfrey 8198, ex Herb. Gray. GEORGIA: Dekalb Co., Stone mt. (1000–1686 ft.), Sept. 1894, J. K. Small; Dr. Boykin ex Torrey Herb. FLORIDA: Tallahassee, N. K. Berg. Summer. ALABAMA: auburn, Price woods, 14 Oct. 1900, F. S. Earle. KENTUCKY: Pine mountain, Sept. 1893, T. H. Kearney Jr. 385. TENNESSEE: Southern Appalachian Expedition, South White Creek, 22 Sept. 1933, S. Appalachian region, Kiawasse Valley, fields, Oct. 1898, A. Ruth. Knoxville, dry soil in woods, Oct. 1898, A. Ruth 50; dry pine woods, Oct. 1897, A. Ruth 237, 735; along French Broad River between Paint Rock and Del. Rio, 12 Sept. 1897, Kearney Jr. 939. MISSISSIPPI: Panola County, sandy places, 16 Sept. 1896, H. Eggert; Ocean Spring, 10 Oct. 1898, Tracy 4761 (NY).

Flowering—Commonly during Sept. to Oct.

Distribution—U.S.A., damp woods, open ground and borders of fields—southern New Jersey to S. Indiana, S. Missouri and Oklahoma, south to Florida and Texas.

7. *ERIANTHUS VIGUIERI* A. Camus, Bull. Soc. Bot. France 71: 1182, 1925.

Perennial grass. *Culm* 35–40 cm. tall, thin, pubescent below the panicle; nodes bearded with long hairs. *Lamina* rigid, erect, 22–25 cm. long, glabrous below, pilose at apex; leaf sheath waxy above. *Panicle* 11–12 cm. long, dense, violet; branches 1–4 cm. long. *Spikelets* 7 mm. long; callus hairs dense, one third the length of the glumes; glumes I and II 7 mm. long, dorsally villous; glume III 6.5 mm. long; IV 3 mm. long, with twisted awn 10–11 mm. long; stamens 3, with anthers 4–4.5 mm. long.

The above description has been translated from the original since no specimen could be secured. Camus remarks that it is distinct from other species of *Erianthus* in the short, violet inflorescence and in the leaves.

Type—Viguier and Humbert No. 1721, 27 Nov. 1912, from Ambatofotsy and Tsiarafajavona (2000–2400 m.), Ankaratra, Katsamby district, Itasy province, Madagascar.

Distribution—Madagascar.

8. *ERIANTHUS BALANSAE* Hackel in DC. Monog. Phan. 6: 133, 1889.

Culm about 1 m. long, pubescent below the panicle; nodes hairy. *Lamina* linear, 20–30 cm. long, 6–8 mm. broad. *Panicle* about 18 cm. long with branches 4–6 cm. long. *Spikelets* 8 mm. long with dense callus hairs almost as long as spikelet, glumes pilose; glume I bidentate; awn 16–19 mm. long twisted; anthers 2 mm. long.

This is a rare species, which is not well represented in collections. It is closely related to *E. asper* from which it differs in narrower leaves and hairy glumes. As I could not secure any specimens, I translated Hackel's description.

Type—Balansa 301 from Caaguaza, Paraguay.

Distribution—South America—Paraguay.

9. *ERIANTHUS ASPER* Nees, Agrost. Bras. 315, 1829; Hack. in Mart. Fl. Bras. 2(3): 258, 1883; Hack. in DC. Monog. Phan. 6: 133, 1889; Correa Diccion. Pl. Uteis. Brasil 1: 627, 1926. *Saccharum asperum* Steud. Syn. Pl. Glum. 1: 407, 1855. *Saccharum Brasilianum* Trin. Mem. Acad. Petersb., Ser. 6, 2: 311, 1832. *Erianthus brasilianus* Anderss. Öfv. Svensk. Vet. Akad. Forh. 12: 162, 1855. *E. cuspidatus* Anderss. l.c. 162.

An erect grass in small clumps with usually single flowering culm, about 2 m. long; nodes sometimes with prominent circle of hairs; axis with adpressed hairs below the panicle. *Lamina* narrow, 80–100 cm. long, 0.6–2 cm. broad, glabrous or hairy above; leaf sheath glabrous or hairy. *Panicle* 20–40 cm. long, with 3–5 cm. long spreading branches, with prominent pinkish callus hairs. *Spikelets* 4–6 mm. long; rhachis joint about 3 mm. long; pedicel about 3 mm. long. Glumes I and II completely glabrous; awn straight, about 8 mm. long; anthers about 2 mm. long. *Var. typicus* Hack. in DC. Monog. Phan. 6: 134, 1889.

Culm glabrous; leaf sheath glabrous, *lamina* almost glabrous; *panicle* rhachis slightly pilose; *spikelets* 6 mm. long with awns about twice as long.

Var. BRASILIANUS (Trin.) Hack. in Mart. Fl. Bras. 2(3): 259, t. 61, 1883.

Culm hairy below panicle; leaf sheath villous above; *lamina* puberulous above; *panicle* rhachis densely hairy; *spikelets* 4–5 mm. long with awn slightly longer than spikelet.

The two varieties are not very clear cut. The species is closely related to *E. saccharoides*, from which it differs in having glabrous glumes I and II.

Type—based on *Saccharum asper* Nees.

Sheets examined—BRAZIL: Juiz de Fora, Minas Geraes (800 m.). 21 Feb. 1925, Agnes Chase 8575; Goyaz Province, 12 March 1870, N. A. Glaziou 4299, ex Herb. Mus. Paris. COLOMBIA: Puerto Barrie (130–140 m.), Jan. 1918, F. W. Pennel 3715 (no flowers, it is doubtful whether it belongs to *E. asper* (NY)).

Flowering—Dec.–February.

Distribution—Brazil at higher altitude in the mountains; and Argentina.

10. *ERIANTHUS SACCHAROIDES* Michx. Fl. Bor. Am. 1: 555, 1803; Silveus, Texas Grasses 707, 1935. *Andropogon erianthus* Link, Hort. Berol. 1: 243, 1827. *Erianthus saccharoides* Michx. s. sp. *genuinus* var. *Michauxi* Hack. in Mart. Fl. Bras. 2(3): 257, 1883. *E. Fischerianus* Rupr. ex Doell l.c. 258, 1883. *E. saccharoides* Michx. s. sp. *genuinus* and s. sp. *angustifolius* Hack. in DC. Monog. Phan. 6: 130-132, 1889. *E. angustifolius* Nees, Agrost. Bras. 316, 1829. *Saccharum angustifolium* (Nees) Trin. Mem. 4: 92, 1836.

Culms to 4 m. tall, appressed-villous below the panicle; nodes hairy or glabrous. Leaf sheath hairy; *lamina* about 30-36 cm. long, 4-6 mm. wide, hairy. *Panicle* 18-20 cm. long, with 4-5 cm. long spreading secondary branches; culm hairy below inflorescence. *Spikelets* 5-6 mm. long; rhachis joints about 4 mm.; pedicels 2-3 mm.; callus hairs shorter than spikelets; glumes I and II dorsally villous; awn straight, 1.5-2.0 cm. long.

This is closely allied to *E. alopecuroides* but differs in having hairy leaf sheath and narrower lamina, callus hairs shorter than spikelets, and straight awn.

Type—Michaux's specimen from south east U.S.A.

Sheets examined—CUBA: Pinar del Rio province, Laguna Jovero to Herradura, 12.12.1911, J. A. Shafer 10934, "6-8 ft. tall, in water"; Laguna San Mateo, C. Wright 3903. BRAZIL: 1836-41, G. Gardner 851; Minas Geraes, Hargreaves (1350-1400 m.), 21-22 Dec. 1929, Agnes Chase 10257; New Grenada, Lindig 1124; Goyaz Province, 1896, A. Glaziov 22380; Minas Geraes, Capanemea, M. Claussen 1843 ex Hb. Mus. Paris; Chapman ex Torrey Herb. (locality not given). Riedel 1654 ex Herb. Horti Petropolitani (Type for *E. Fischerianus*). ARGENTINA: Gobernacion de Formosa, 14.8.1920, A. Wetmore 756. BOLIVA: Pampas near Lake Rogagua, Amazon Basin, open swampy ground, 12.3.1921, O. E. White 1208. U.S.A.: N. CAROLINA: Wilmington, 30.8.1905, A. S. Hitchcock. KENTUCKY: 1840, C. W. Short. VIRGINIA: Norfolk County, Northwest, 6.9.1893, Heller 1313. S. FLORIDA: Herb. Chapman (NY).

Flowering—August to December.

Distribution—Brazil, Argentina, Colombia, Bolivia, Cuba, and U.S.A.

1. Culm glabrous below panicle.
1. Panicle narrow contracted.

11. *ERIANTHUS STRICTUS* Baldw. in Ell. Bot. S.C. & Ga. 1: 39, 1816; Hack. in DC. Monog. Phan. 6: 136, 1889; Silveus, Texas Grasses 727, 1935. Hitchcock, Man. Grasses U.S. 721, 1935. *Saccharum strictus* Nutt. Gen. Pl. 1: 60, 1818. *Saccharum Baldwinii* Spreng. Syst. Veg. 1: 282, 1825. *Pollinia dura* Trin. Mem. Acad. Petersb. Ser. 6, 4: 91, 1836. *Andropogon durus* Steud. Nom. ed. 2, 1: 91, 1840. Narrow Plume Grass.

Culm 1-2 m. tall, relatively slender, glabrous, nodes sometimes hirsute. *Lamina* 15-70 cm. long, 4-12 mm. wide, flat, narrowed towards base, attenuated to a slender point, glabrous along midrib above the base; *sheaths* shorter than internodes, glabrous, *ligule* membranous, arcuate 1-2 mm. long. *Panicle* reddish brown, 20-40 cm.,

rarely 80 cm. long, 1–2 cm. wide, very narrow; branches 5–10 cm. long, closely appressed; axis and branches completely glabrous; rachis joints 6–9 mm. long. *Spikelets* brown, linear lanceolate, 8–11 mm. long, scabrous, nearly naked to sparsely and very shortly hairy at base; awn straight, very long, about 1.5–2 cm.; glume I and II toothed, glabrous; glume II completely glabrous; sterile lemma 6–7 mm. long, dark purple, lemma 5–6 mm. long. Palea 1.5–2.5 mm. long.

Very distinct in the narrow, almost glabrous, inflorescence and long spikelets with straight long awn. *E. brevibarbis* is near *E. strictus* but differs in having broader inflorescence and more copious callus hairs.

Type—Baldwin's specimen from Savannah, Ga.

Sheets examined—U.S.A.: MISSOURI: Campbell, 7.10.1910, Swamps B. F. Bush 6384. VIRGINIA: Sussex Co. Waverly, 10.9.1937, Fernald and Long 7299. ARKANSAS: Clay Co., Corning, 25.9.1939, D. Dewaru 20330; Pulaski Co., moist open grassy places, Sept. 1886, H. E. Hasse. MISSISSIPPI: Lonoke Co., Carlisle, low wet woods, 10.3.1931, Demaree 8401. GEORGIA: Arrien Co., Tifton, 29.9.1902, R. M. Harper 1691. ALABAMA: Tuscaloosa Co., Rocky Sheal in Hurricane Creek, 24.10.1908, R. M. Harper 136. LOUISIANA: Hale, Chapman; Saline River, Dr. Hale 612. MISSISSIPPI: Kashtaw, 13 Oct. 1898, S. M. Tracy 4672; Nicholson, along Pearl River, T. H. Kearney Jr. 465. TENNESSEE: Nash; A. Gattinger 162; Tullahoma, Sept. Curtiss 3629. FLORIDA: Herb. Chapman 108.

Flowering—Commonly during September to October.

Distribution—U.S.A. Texas to Florida, N. Carolina, Tennessee, Missouri, mostly in marshes.

12. *ERIANTHUS HOSTII* Griseb. Spicil. Fl. Rumel. 2: 548, 1844; Hack. in DC. Monog. Phan. 6: 141, 1889; Stoyanoff and Steffanoff, Flore Bulgarie 91, 1925. *Andropogon strictus* Host. Icon. Gram. Austr. 2(2): t. 2, 1802. *Saccharum strictum* (Host.) Spreng. Pl. Pugill. 2: 16, 1815 non Nutt. *Ripidium strictum* Trin. Fund. 169, 1820. *S. adpressum* Kit. ex Reichb. Fl. Germ. Excurs. 34, 1830. *Erianthus strictus* Bluff. et Fingerh. Comp. Fl. Germ. ed. 2, 1: 105, 1836, non Baldw. *E. orientalis* C. Koch. Linnaea 19: 5, 1847.

Rhizomes creeping. *Culm* 1–2 m. long, narrow with 4–5 nodes, glabrous or sparingly scabrous, pubescent below the panicle. *Leaf sheath* glabrous or slightly scabrous above; nodes glabrous or hairy. *Lamina* 30–40 cm. long, 1–2 cm. broad, pilose at base on the upper surface. *Panicle* 15–30 cm. long, lax, very narrow and linear; secondary branches few, separated at a distance of 1.5–2.5 cm., generally about 3–4 cm. long. *Spikelets* densely arranged on the secondary branches almost from base, about 5 mm. long, violet tinged; pedicel almost the same length; callus hairs few, about half the length of spikelets. *Sessile spikelet*—Glume I chartaceous, emarginate-bidentate, slightly pilose above; II oblong, chartaceous, 3-nerved, scabrous at base; III smaller in size, oblong, membranous, ciliate above; IV equal to III, lanceolate, acute, glabrous, short-awned; awn 2–3 mm. long, exerted. *Palea* smaller than glumes, linear-lanceolate. Lodicules glabrous. *Anthers* 3 mm. long.

This is distinct from other species mainly in the laxly branched panicle with densely aggregated spikelets with short awn. Culms very thin and narrow.

Sheets examined—Sedi-Chig; Guzel-Dere, June–October 1855, Balansa 48 ex Herb. Gray. GREECE: Trojan, Mount Urea, Kamandri, 29/7/1883, Ascherson 495 ex Hb. Boiss. ORIENT: Kurdistan, Mardin, Lenar, 11.VII.1888, O. Stapf 132 (CAL). IRAQ: Jebel Baykhar near Zakhe, 15–18 June 1934, H. Field and Y. Lazar 1860 (NY).

Flowering—June–July.

Distribution—S. Hungary; E. Serbia; Byzantine; Dalmatia; Monte Negro; Lydia; Silesia; N. Syria; Kurdistan; Greece.

13. *ERIANTHUS BREVIBARBIS* Michx. Fl. Bor. Amer. 1: 55, 1803; Hitchcock, Man. Grasses U. S. 723, 1935. *Saccharum brevibarbe* Pers. Syn. Pl. 1: 103, 1805. *Calamagrostis rubra* Bosc. ex Kunth, Enum. Pl. 1: 478, 1833. *Erianthus alopecuroides* var. *brevibarbis* Chapm. Fl. South U. S. 583, 1860. *E. saccharoides* Michx. subsp. *brevibarbis* Hack. in DC. Monog. Phan. 6: 131, 1889. Common name—Brown Plume grass.

A tufted grass with only flowering shoots. *Culms* 1–2 m. tall, glabrous even at the nodes and below the panicle. *Lamina* linear, 40–80 cm. long, 6–15 mm. wide. *Panicle* 20–40 cm. long, brown or purplish, not conspicuously woolly; axis glabrous below panicle; secondary branches 5–6 cm. long. *Spikelets* 6–7 mm. long, brown, scabrous; callus hairs very scanty, much shorter than the spikelets (2–3 mm.); rhachis joint and pedicel 5 mm. long, scantily pilose; glumes I and II of both spikelets glabrous; awn conspicuous, straight 18–20 mm. long.

This is conspicuous for its straight awns and short callus hairs by which it can be distinguished from *E. contortus*.

Type—Michaux's specimen from Tennessee and Carolina.

Sheets examined—U.S.A.: GEORGIA: Barrien County, S. W. of Tifton, moist hollow at base of sand hills of Little River, 29 Sept. 1902, R. M. Harper 1693 (Geological formation: Oligocene overlaid by Lafayette and Columbia). FLORIDA: Thickets bordering pond near Live Oak, 10 Oct. 1901, A. H. Curtiss 6940 (NY and CAL). VIRGINIA: Herbaceous ground, 24 Oct. 1898, G. V. Nash. SOUTH CAROLINA: Georgetown County, Swale 5 miles south of Andrews, 11 Sept. 1939, R. K. Godfrey 8191. LOUISIANA: Calcasieu Co. Oberlin, 8 Sept. 1898, C. R. Ball 194; Dr. Hale (NY).

Flowering—September to October.

Distribution—Moist places in Coastal plains from Delaware to Florida and Louisiana (U.S.A.).

14. *ERIANTHUS CONTORTUS* Bald. in Ell. Bot. S.C. and Ga. 1: 40, 1816; Silveus, Texas Grasses 706, 1933; Hitchcock, Man. Grasses U.S. 722, 1935. *Saccharum contortum* Nutt. Gen. Pl. 1: 60, 1818. *Erianthus alopecuroides* var. *contortus* Chapm. Fl. South U.S. 582, 1860. *Erianthus saccharoides* Michx. subsp. *contortus* Hack. in DC. Monog. Phan. 6: 131, 1889. *Erianthus Smallii* Nash, Bull. N.Y. Bot. Gard. 1: 429, 1900. Common name—Bent awn Plume grass.

Culms 1–2 m. tall, glabrous below panicle and at nodes. *Lamina* 15–90 cm. long, 1–1.5 cm. wide. *Panicle* 15–35 cm. long, narrow, densely flowered; secondary branches 6–10 cm. long. *Spikelets* 6–8 mm. long, with callus hairs almost as long as spikelet; rhachis joints about

6 mm. long; pedicel 4 mm. long; glumes I and II dorsally glabrous; glume III with 2 cm. long awn, spirally coiled at base.

This is very close to *E. alopecuroides* which differs by lax, spreading inflorescence with dense callus hairs much longer than spikelet, and glume I with very few long hairs on the back. Therefore the two species should be kept separate.

Type—Baldwin's specimen from Savannah, Ga.

Sheets examined—U.S.A.: GEORGIA: De Kalb Co., Stone Mountain (1000–1686 ft.), 6–12 September, 1894, J. K. Small (type of *E. Smallii*). VIRGINIA: Cape Henry, Seashore State Park, Salt Spray scrub zone, 5.9.1940, F. E. Egler 40–398. ARKANSAS: Nevada Co., Prescott, common in creek bottoms (200 ft.), 10–6–40, D. Demaree 21744; Pulaski Heights, Little Rock, 23.9.1931, D. Demaree 9699, 9744. SOUTH CAROLINA: September, H. Ravevel (NY); Orangeburg Co., 16.8.1905, A. S. Hitchcock, Amer. Gr. Nat. Herb. No. 284 (CAL). LOUISIANA: Bossier Parish, moist open soil, 3 miles N.E. of Alden Bridge, 7.8.1938, Blomquist 10129; De Soto Parish, near Harts Bluff, H. L. Blomquist 10183, 10.8.1938. NORTH CAROLINA: Lincolnton, Curtis 1835. FLORIDA: Tallahassee, N.K. Berg. ex Hb. Small. KENTUCKY: Dr. Hale 1840 (NY).

Flowering—August to October.

Distribution—U.S.A. Moist sandy pineland or open grounds in coastal plains, Maryland to Florida and Texas, north to Tennessee and Oklahoma.

12. Panicle broad with spreading basal branches.

15. *ERIANTHUS GRIFFITHII* (Hack.) Hook. F. Fl. Brit. Ind. 7: 122, 1896; Pilger in Eng. and Prantl, Pflanzenfam. ed. 2, 14e: 118, 1940. *Saccharum Griffithii* Munro ex Aitchis. Journ. Linn. Soc. Bot., 19: 191, 1882, name only; Hole, Ind. For. Mem., For. Bot. Ser. 1: 68, 1911. *Saccharum ciliare* Anderss. var. *Griffithii* Hack. in DC. Monog. Phan. 6: 119, 1889.

A grass forming well-defined tufts. *Culms* all flowering, solid, up to 2 m. tall. *Lamina* about 60–100 cm. long, narrow, about 8 mm. wide; leaf sheath almost glabrous. *Panicle* 15–40 cm. long densely flowered and densely villous; axis glabrous below panicle. *Spikelets* 4–6 mm. long; pedicels 2–3 mm. long; rhachis joints 2–3 mm.; callus hairs yellow, slightly shorter than spikelets; gl. I and II of pedicelled and sessile spikelet dorsally villous; awn 1.5 mm. long included; palea ciliate.

This species is based on Aitchison's specimens from Afganistan and named by Munro as *S. Griffithii* (1882) but without description which had been reduced to *S. ciliare* var. *Griffithii* by Hackel, and later (1897) transferred to *Erianthus Griffithii* by Hooker. Hooker however, included a specimen collected by Thomson at Rondou, Tibet, which has spikelets with "*exserted awns*", which according to Hole (1911) undoubtedly belong to *E. Ravennae*.

Type—Aitchison No. 440, 467, 271, Kuram district, on the arid, shingle plains and borders of fields, up to 6000 ft. in Afghanistan.

Sheets examined—AFGHANISTAN: Kurram Valley, 13.8.1880, J. E. T. Aitchison 440 (co-type); 6.9.1880, Aitchison 546 (this is a very distinct

plant with densely flowered panicle about 50 cm. long, densely villous and with stout culm). Jhelum 8.10.1902, Flora Pentapotamica ex Hb. J. K. Drummond 15, 108 (CAL). PAKISTHAN: Rawalpindi, Sohan River, dry rocky places, Oct. 1949. R. R. Stewart 23387 (N.Y.).

Flowering—October.

Distribution—Afghanistan, Pakisthan, Baluchistan.

16. *ERIANTHUS FILIFOLIUS* Nees ex Steud. Syn. Pl. Glum. 1: 409, 1855; Hack. in DC. Monog. Phan. 6: 146, 1889; Hook. f. Fl. Brit. Ind. 7: 123, 1896. *Saccharum filifolium* Steud. Syn. Pl. Glum. 1: 409, 1855; Duthie, Grasses N.W. India 14, 1883. *Saccharum versicolor* Steud. Syn. Pl. Glum. 1: 409, 1855. *Erianthus versicolor* Nees ex Steud. Syn. Pl. Glum. 1: 409, 1855; Hack. in DC. Monog. Phan. 6: 144, 1889; Hook. f. Fl. Brit. Ind. 7: 124, 1896.

Culm about 1 m. tall, glabrous or slightly pubescent below the panicle, with circlet of hairs at node. *Lamina* very narrow, linear, 20–40 cm. long, 3–4 mm. broad. *Panicle* 20–25 cm. long, laxly branched; secondary branches up to 8–10 cm., without spikelets at base. *Spikelets* 6 mm. long; rhachis joint 4–5 mm. long; pedicels 2–3 mm. long; callus hairs as long as spikelet, whitish or pinkish; glumes I and II dorsally glabrous; awn straight, about 15–20 mm. long.

I have reduced *E. versicolor* to *E. filifolius*, since they appear to be similar. The differences suggested by Hooker regarding pubescence on axis of panicle and length of callus hairs do not appear to be significant in the specimens examined. These differences can be accommodated under var. *pallens*. Hooker himself was doubtful regarding the validity of the two species, as he remarked under *E. versicolor* "I very much doubt this being distinct from *E. filifolius* and the following".

Type—Royle 207 from Nepal.

Sheets examined—INDIA: W. HIMALAYAS: Simla Hills, Bushahar State, Dec. 1913, R. S. Hole 217; Muree, common on the hills at 4500 ft.; Hazara, Kagan, 6 Aug. 1897, Inayat 22676; 19 July 1896, Inayat 20326; Chitral Relief Expedition, Dir, 12 May 1895, Harriss 16780; Mussorrie Range, 1869, G. King; Jaunsar, Mundhole (6000 ft.), May 1898, Gamble 26791; Kathyan, May 1898, Gamble 23781; Kumaon, June 1857, T. Anderson; Kashmir, Gilgit (6–7000 ft.), T. Thomson ex Herb. Ind. Or; Nittar Valley, 3 Aug. 1892, J. F. Duthie 12329 (CAL). Rapur-Mussorie Road (4500 ft.), May 1931, R. R. Stewart 13470. PUNJAB, Kangra Valley, Kulu (5000 ft.), June 1933, W. Koelz 4919. W. NEPAL: Doti district, Ratrrligaon, 2 May 1929, Bis Ram 346 (NY). Nepal Frontier, 2 May 1900, Inayat 23905 (CAL). BALUCHISTAN: Homja, 8 June 1897.

Flowering—May–July.

Distribution—India, Himalayas, Kashmir to Nepal, at an altitude of 3000–8000 ft., common in Simla Hills. Baluchistan.

Var. *PALLENS*, Hook. f. Fl. Brit. Ind. 7: 124, 1896; *E. pallens* Hackel in DC. Monog. Phan. 6: 145, 1889.

Culm slightly pubescent below the panicle; *lamina* flat; *spikelets* 6 mm. long; awn 18–24 mm. long.

17. *ERIANTHUS HOOKERI* Hackel in DC. Monog. Phan. 6: 142, 1889; Hook. f. Fl. Brit. Ind. 7: 125, 1896; Bor, Fl. Assam, 5: 326, 1940.

Culm up to 2 m. tall, smooth, pubescent below the panicle. *Lamina* broad, flat, 30–50 cm. long, 1–3 cm. broad; sheaths closely fitting, smooth and glabrous, villous at blade joint. *Panicle* usually 20–30 cm. long, sometimes up to 45 cm., laxly branched, secondary branches at base 7–10 cm. long. *Spikelets* 5–5.5 mm. long; pedicels and rhachis joint 3–4 mm.; callus hairs long; glume I two-toothed, dorsally villous with long hairs at base below the middle; glume II almost glabrous; awn straight, 2–3 times as long as spikelet.

It is nearly related to *E. filifolius* and *E. longisetosus* but differs in having (1) glume I dorsally villous, (2) leaves broader and flat, and (3) the culm pubescent below the panicle.

Type—Hooker's specimen from tropical Sikkim, marked as *Erianthus* 15 in Herb. Kew.

Sheets examined—INDIA: SIKKIM (Regio Trop.): "J. D. H., *Erianthus* 15 ex Herb. Ind. Or." (cotype); Darjeeling, Panchkilla (1000 ft.), 29 Feb. 1876, C. B. Clarke 27080c; Teesta (500 ft.), 4 March 1871, Clarke 13947E; Feb. 1874, Clarke 3727B (common tall grass on the lower hills above Sevoke); Sukna, Terai, 23 Feb. 1914, Ribu and Rhomoo; Terai, 9 Feb. 67, Dr. Anderson; Terai, S. Kurz; Bootan Side of Teesta (2000 ft.), 14 Feb. 76, G. King; Bhutan, 23 Jan. 1878 (unnamed). W. HIMALAYAS: Dehra Dun (1000 ft.), Feb. 1892, J. S. Gamble 2340; March 1893, Gamble 24060; Terai (3000 ft.), May 1891, Gamble 22750). ASSAM: Kamrup, Mathaguri, 26 Jan. 1915, UN. Kanjilal 5051 (Vern. Dhusghas in Nepali). BURMA: S. Shan State, Mong Hang (3000 ft.), Aug. 1924, R. H. Phillimore 48; Dr. Brandis ex Herb. S. Kurz; Chin Hills, Minbu, Polse (4500 ft.), Jan. 1903, Sk. Mokim 1133, 1153, 1161. CHINA: Yunnan Expedition, 2 March 1868, D. J. Anderson (CAL). Mongthe, Jan., A. Henry 9660 (in this plant the culm is almost glabrous below the panicle) (NY).

Flowering—Commonly during Feb.–March.

Distribution—India—Common in Sikkim and Assam at 1000–3000 ft.; Bhutan; Burma and China (Yunnan).

18. *ERIANTHUS LONGISETOSUS* Anderss. Öfv. Svensk. Vet. Akad. Forh. 12: 163, 1855; Hack. in DC. Monog. Phan. 6: 143, 1889; Anderss. in Clarke, Journ. Linn. Soc. Bot. 25: 82, pl. 34, 1889. *E. mishmeensis* Munro ex Hook. f. Fl. Brit. Ind. 7: 124, 1896.

Culms 2–2.5 m. tall, smooth, reedlike, glabrous below the panicle. *Lamina* 30–90 cm. long, flat, 1.5–4 cm. broad; sheaths loose, hairy or glabrous. *Panicle* 15–45 cm. long, densely branched, secondary branches 7–10 cm. long. *Spikelets* 4.5–5 mm. long; with golden-yellow callus hairs about 8 mm. long; pedicels 5–6 mm. long; rhachis joints 8–10 mm. long; glume I bidentate, dorsally glabrous glume II glabrous; awn very long, straight, about 2 cm.

This is allied to *E. filifolius* but differs in having flat, broader leaves, larger panicle with longer golden yellow callus hairs and longer rhachis joints.

Sheets examined—INDIA: Wall. Cat. 8846. ASSAM: Garo Hills, Rongenggiri (3000 ft.), 19 March 1915, Kanjilal 5318; Shonnagiri (1400 ft.), 8 Feb. 1886, C. B. Clarke 43031. Jaintia, Jowye (3500 ft.), 13 Dec. 1885, Clarke 42473A. Khasia, Burney Hat (1000 ft.), 17 Feb.

1885, Clarke 37279A; Gowhatty, Sept. 1850, Master 290, 299. Mishmi Hills, Griffith. Mikir Hills, Feb. 1848, Master; Abor Expedition, Janakmukh, 17 Dec. 1911, I. H. Burkill, 37206. 1875, J. L. Lister. CHITTAGONG HILL TRACTS: 6 Feb. 1873, Clarke 19595. N. CHINA: Yunnan Expedition, D. J. Anderson. BURMA: Minbu, Chin Hills, Polse (4500 ft.), Jan. 1903, Sk. Mokim 1133 (CAL).

Flowering—Commonly during Feb.-March.

Distribution—India—Common in the Hills of Assam, and Chittagong Hill Tracts; China—Yunnan; Burma.

19. *ERIANTHUS BECCARII* (Stapf.) Jansen, Reinwardtia, 2: 275. 1953. *Spodiopogon Beccarii* Stapf, Kew Bull. 228, 1898. *E. decussylvae* Ridl. Journ. Malayan Branch Roy. As. Soc. 1: 110, 1923. *E. sumatranus* Henrard in Fedde Report. 22: 349, 1926.

Tufted grass forming a bush about 1 m. tall. *Culms* erect, robust, villous or almost glabrous below the panicle. *Lamina* about 18–30 cm. long and 2–3.5 cm. broad; midrib hairy above blade joint; leaf sheath glabrous. *Panicle* lax, subeffuse, about 15 cm. long, with spreading 7–8 cm. long secondary branches; branches without spikelets at base; axis glabrous or villous. *Spikelet* 3–3.5 mm. long; callus hairs pink, longer than spikelets; rhachis joints about 4 mm. long; pedicels 2 mm., glumes I and II dorsally glabrous, without any long hairs; awn about 6–9 mm. long, slightly twisted.

A most beautiful and attractive grass with its coppery purple panicle (Ridley).

Type—based on *Spodiopogon Beccarii* Stapf (type in Herb. Florence); type of *E. sumatranus* in Herb. Lugd. Bat. Sumatra: Sibolangit, Petani Valley (1300 m.), Lörzing No. 6012; 28 Aug. 1918.

Sheet examined—SUMATRA: East Coast, Tapanoeli, Sebolgu to Jarveting, roadside edge of forest (3500 ft.), 29 May 1927, H. S. Yates 2533 (NY).

Distribution—Sumatra.

20. *ERIANTHUS PERRIERI* A. Camus, Bull. Soc. Bot. France 71: 1182, 1924.

Perennial grass. *Culm* 1.5–2 m. tall, robust, glabrous below panicle. *Lamina* 80 cm. long, 1 cm. broad, glabrous or pilose; leaf sheath elongated, glabrous above, ciliate at margins. *Panicle* dense 20–25 cm. long; secondary branches 3–6 cm. long, without spikelets near base; rhachis joints 2–3 mm. long, pedicels about 4 mm. *Spikelets* 4.5–5 mm. long, yellowish; callus hairs longer than spikelets; glume I 4.4–4.9 mm. long, bidentate, glabrous or sparsely pilose; glume II 4.5–5 mm. long, glabrous; glume III 4.3–4.8 mm.; glume IV 1.5 mm. long, hyaline, with awn 9–10 mm. long.

Since I could not secure any specimen, the description has been translated from the original.

Type—Perrier de la Bathie No. 10723 from basaltic rocks at Be'tafo, central Madagascar (rarely found).

Distribution—Madagascar.

15. Panicle usually 30–90 cm. in length.

21. *ERIANTHUS TRICHOPHYLLUS* Hand.—Mazz. Anz. Akad. Wiss.

Math. Nat. VI. (Wien) 62: 254, 1926. *E. Griffithii* var. *trichophyllus* Hand.—Mazz. op. cit. 58: 154, 1921.

Flowering culm 40–100 cm. long. *Lamina* 70–100 cm. long, 4–5 mm. wide, with long hairs below along midrib; ligule truncate, 1.5 mm. long. *Panicle* narrowly pyramidal, 30–90 cm. long; lax, with secondary branches at base about 25 cm. long; rhachis joints 2–3 times as long as spikelets, pedicels of same length; glumes 3.5–4 mm. long, 5 and 3 nerved, dorsally villous; awn short, exserted. Lodicules 1 mm. long. Anthers about 1.5 mm. long.

It is allied to *E. Griffithii* but differs in longer, lax, inflorescence and spikelets with exserted awn. Since no specimen could be secured, the description is translated from the original.

Type—China: Yunnan, Handel-Mazzetti Nos. 745, 11016.

Distribution—China.

22. *ERIANTHUS PROCERUS* (Roxb.) Raizada, Ind. For. Rec., New Ser., 4: No. 5, 98, 1954 (name only). *Saccharum procerum* Roxb. Fl. Ind. ed. Carey, 1: 248, 1820; Parker, Ind. For. 56, t. 33, 1930; Bor Fl. Assam 5: 320, 1940. Under *S. arundinaceum* Hack. in DC. Monog. Phan. 6: 117, 1889; Hook. f. Fl. Brit. Ind. 6: 119, 1896; Hole in Ind. For. Mem., Bot. Ser. 1: 68, 1911; Haines, Bot. Bihar and Orissa 1012, 1924. *S. benghalense* Retz. Obs. 5: 16, 1789.

A very tall grass with only flowering culms attaining a height of 4–6 m. *Culms* 1.4 cm. or less in diam., glabrous below the panicle. *Lamina* 1.2–1.8 m. long, 1.2–2.5 cm. wide; midrib densely hairy above arcuate ligule; leaf sheath glabrous. *Inflorescence* large, 60 to 120 cm. long, with much elongated spreading secondary branches almost of same length as the main axis at base, very laxly flowered. *Spikelets* lax, 2.5–3.0 mm. long; rhachis joints 5–7 mm. long; pedicels 2.5–3.0 mm. long; glumes I and II of pedicelled spikelet dorsally villous; glume I of sessile spikelet dorsally villous, glume II glabrous; awn short, about 1 mm. or less, usually included.

There has been great confusion regarding this species. It was proposed by Roxburgh in 1820, but Hackel (1889) referred it to *Saccharum arundinaceum* Retz. Hole (1911), Hooker (1896), and Haines (1924) accepted this reduction, but Bor (1940) restored this species as *Saccharum procerum*, since it flowers after the flowering of *S. arundinaceum* is over, and possesses a “much looser” panicle with longer rhachis joints and pedicels. Roxburgh also stated that this plant is the most beautiful of the genus. It comes nearest to *S. officinarum* but is a taller and much more elegant plant.

I have seen these plants growing commonly in the Terai region at the base of Sikkim Himalayas, especially on the banks of Tista River near Sevoke. It is distinct from *E. arundinaceus* in possessing culms all of which flower, narrower leaves, longer, laxer panicles with longer secondary branches, pinkish shorter spikelets on longer rhachis joints and pedicels.

As the plants show the characteristics of *Erianthus* in their vegetative and floral characters, I am transferring the species to *Erianthus*.

Type—Roxburgh's drawing of *S. procerum*.

Sheets examined—INDIA: Wall. Cat. 8852B, 8853E (CAL). ASSAM: Purong, February 1875, O. Kuntze 3759 (NY); Sadiya, 23 Nov. 1911,

Burkill 35776; Sadiya (1000 ft.), H. Collet; Assam Deputation collection 1835; Gowhatty hills, Jan. 1853; River Bank at Neghering, 30 Dec. 1900; A. C. Chatterjee 8; River Bank at Singrighat, 28 Dec. 1900. SIKKIM: J. D. Hooker; Gamble; Ramon, 9 Nov. 57, T. Thomson; 22 Nov. 1874; Dr. Treutler; Darjeeling, Ryang (2000 ft.), 10 Nov. 1870; Clarke 13661B, 1 Dec. 1875; Clarke 26494B (CAL), 27 Nov. 1875, O. Kuntze 7029. GANGETIC PLAINS: T. Thomson ex Herb. Hook. and T. Thomson. BURMA: Mergui, 22 Jan. 1930; R. N. Parker 3140, "vern. Palauk Chaung" (NY); Fort Stedman, 1893; Abdul Khalil, Myithi Phuni (3500 ft.), 13 Nov. 1885; C. B. Clarke 41963, Pegu, S. Kurz. INDOCHINA: Tonkin, Tu-Phap, 20 Nov. 1888; B. Balansa 1723, 3 Jan. 1886; Balansa 1721 (CAL). Annam, Hue and vicinity, May-July 1927; J. & M. S. Clemens 4480 (NY). MALAYA: Perak River Dec. 1880, Dr. King's Collector; Pahang, Pekan, May 1890, H. N. Ridley 1202; Singapore, 1890, Ridley 10800. BORNEO: Beccari 3055, Plantae Bornensi. CHINA: Whampoa, Nov. 1860, herb. Hance No. 1406. FIJI: 1860, B. Seeman 691 (CAL).

Flowering—Usually during Nov.-Dec.

Distribution—India; Assam; Sikkim; Burma; China; Malaya; Indochina; Borneo; Fiji. Very common in Assam and Sikkim, found in wet low lying places in the plains and also in the hills up to an altitude of 3000 ft.

Var. *elegans* (Jesw.) Mukherjee, comb. nov., *E. ciliaris* (Anderss.) Jesw. var. *elegans* Jesw. ex Backer, Handboek Flora Java 2: 42, 1928. *E. elegans* (Jesw.) Rümke, Arch. Suikerind. Nederl. Indie. Meded. 2: 229, 1934.

Panicle as a rule longer than 1 m. usually attaining about 2 m.; secondary branches at base about 0.5 m. long. Rhachis joint twice as long as spikelet.

This is a conspicuous type with very elegant inflorescences. It has been maintained under cultivation through clonal propagation at Coimbatore Sugarcane Breeding Station. Kobus took this type from India to Java in 1891 under the name of *Saccharum ciliare* Anderss., and Jeswiet named it later *E. ciliaris* (Anderss.) Jesw. var. *elegans*. Rümke raised it to the rank of a separate species, *E. elegans*. I consider it to be a variety of *E. procerus* which has a similar inflorescence with laxly flowered long branches, but of smaller size. The species does not appear to be distinct from others as it is not seen under natural conditions except in the collection of the Research Stations under cultivation.

23. *ERIANTHUS MAXIMUS* Brongn. in Duperr. Bot. Voy. Coquille 2(2): 97, 1831; Hack. in DC. Monog. Phan. 6: 138, 1889; Grassl. Journ. Arn. Arb. 27: 246, 1946; Artschwager in U.S.D.A. Tech. Bull. No. 951, 1948. *Saccharum maximum* Trin. Mem. Acad. Petersb., Ser. VI, 4: 92, 1838. *E. pedicellaris* (Trin.) Hack. in DC. Mon. Phan. 5: 137, 1889.

Culm tall, robust, red purple, glabrous or sparsely pubescent below the panicle; internodes 19–20 mm. thick, bud furrow shallow, center pithy; root band 8–10 mm. high, root eyes 2 rows; buds green with red tip. *Lamina* about 70 to 115 cm. long, 3 to 5.8 cm. broad, dewlap smooth; leaf sheath pubescent at base. *Panicle* about 30–40 cm. long,

effuse above; secondary branches about 20 cm. long, opposite; ultimate branches thin; rhachis joints longer than spikelets, pedicels almost half as long, glabrous. *Spikelets* 4-4.5 mm. long, greenish yellow; callus hairs shorter, one-third as long; glumes I and II glabrous on the back; awn 2-4 mm. long, slightly exserted. *Palea* ciliate. *Anthers* 3, 1.6 mm. long.

Grassl suggests that this species is very closely related to sugarcane. Since I could not secure any specimen of this species, the description is based on that given by Hackel.

Type—*Erianthus maximus* Brongn. (*Saccharum maximum*, based on Brongn. 1831).

Distribution—Polynesia: Tahiti, Fiji, Society Islands, Cook Isl. New Caledonia, Austral. Isl.

24. *ERIANTHUS ELEPHANTINUS* Hook. f. *Fl. Brit. Ind.* 7: 122, 1896; *Bor. Fl. Assam* 5: 323, 1940.

A gigantic grass with *culm* very tall, up to 4 m., robust, stout, smooth and glabrous. *Lamina* up to 1.5 m. long, 5 cm. broad, smooth on both surfaces; leaf sheath smooth and glabrous. *Panicle* up to 40 cm. long, diffuse; rhachis glabrous and polished; branches numerous, lower fascicled, 15-20 cm. long. *Spikelets* 3.5-4 mm. long; rhachis joint 1.5-2 mm. long, pedicels similar; callus hairs as long as or slightly longer than spikelet; glumes I and II sparsely hairy; awn shortly exserted, 2.5 mm. long.

Type—Griffith and Simonds specimens from Assam in Herb. Kew.

Sheet examined—INDIA: Assam; Gowhatti Hills, October (CAL).

Flowering—October.

Distribution—Gregarious grass found in the plains of Assam, India.

25. *ERIANTHUS ARUNDINACEUS* (Retz.) Jeswiet in Arch. Suikerind. Nederl. Ind. 33: Medel. 399, 1925. Heyne, *Nutt. Pl. Ned. Ind.*, ed. 2, 1: 167, 1927; Heyne *Rev. Bot. Appliq.* 9: 1929. *Saccharum arundinaceum* Retz. *Obs.* 4: 14, 1786; Rheede, *Hort. Mal.* 12, t. 46, 1703; Hack. in *DC. Monog. Phan.* 6: 117, 1889; Hook. *Fl. Brit. Ind.* 7: 119, 1896; Hole in *Ind. For. Mem.*, *Bot. Ser.* 1: 68-71, t. 22, 1911; Basu, *Ind. Med. Plants*, t. 1014, 1918; A. Camus in *Lecomte Flor. Gen. Indoch.* 7: 241, 1922; Merrill, *Enum. Philip. Fl. Plants*, 1: 32, 1925; Burkill in *Rec. Bot. Surv. India* 10: t. 7, 1925; *Bor. Fl. Assam*, 5: 320, 1940; Reeder in *J. Arn. Arb.*, 29: 332, 1948.

A very tall grass in clumps, looking very much like cultivated sugarcane. *Culms* biennial, attaining a height of 1.8-2.0 m. in one year; flowering culms attaining 6.8 m. in height and 2-2.5 cm. in thickness; nodes smooth, glabrous; root zone with only one row of root eyes. *Lamina* 1.5-1.8 m. long, 3-7.5 cm. broad, densely villous along midrib at blade joint; *ligule* narrow, truncate, arcuate, ligular process or auricle absent; dewlap absent. *Inflorescence* about 60-75 cm. long, contracted, particularly during fruiting stage; culm glabrous below panicle. *Spikelets* closely aggregated, rhachis joints 3.5-4 mm. long; callus hairs dense, as long as spikelet. *Sessile spikelets* 2.5-4 mm. long with glume II glabrous and I dorsally villous. *Pedicelled spikelets* with both glumes I and II dorsally villous; glume IV with a short awn. *Palea* ciliate on margins. *Lodicules* not ciliate.

There has been much confusion regarding this species and *Saccharum* Sara, *S. procerum*, *S. Munja*, *S. ciliare*, and *S. Griffithii*, all of which were placed under *Saccharum*, perhaps because of similarity in external appearance to sugarcane and because of the very short awn, which is not so conspicuous as in other *Erianthii*. Jeswiet (1925) suggested its transfer to *Erianthus* and this has been supported by Dutt and Rao (Proc. Int. Soc. Sugarcane Tech. 1950: 287-293) on the basis of its distinctive morphological and anatomical characters. It has quite distinct vegetative characters, particularly in living conditions, which warrant its separation from *Saccharum*. Reduction of *S. Sara*, *S. Munja*, and *S. procerum* to this species is perhaps due to inconspicuous differences in the herbarium specimens, but in living condition they are quite distinct from each other. *E. arundinaceus* is the most robust form and possesses contracted panicles with densely aggregated spikelets on short rhachis joints.

Type—probably a cultivated specimen of Retzius from Tranqueber (Hole).

Sheets examined—CHINA: Hainan, Kwangtung, Tam, Hung Mo Mountain, Tsang, Tang and Fung 17663, "Local name Pa Pi Mong"; Kiangsi, Water side (260 m.) 18.10.1932, Steward & Cheo 484. INDO-CHINA: Hue and vicinity, Jan.-May 1927, R. W. Squires 58 (NY). BURMA: Pegu, S. Kurz 1103; Magagu, Moundem (2000 ft.), 6 April 1861, D. Brandis. INDIA: Wall. Cat. 8846; Travancore, 1919, Narayanaswami 1444; Thorii (200 ft.), 30 March 1915, C. C. Calder 1584; Assam, Cachar, Monier Khal on Sonai River, Aug. 1903, A. T. Gage; Sikkim, Labdali, 3 April 1902, Ribu, Terai, Sukna, 23 Feb. 1914, Rubu and Rhomoo (CAL).

Distribution—India: Bengal, Assam, Sikkim, Orissa, Madras, Afghanistan; Ceylon, Siam, Indochina, Malayan Peninsula, Phillipines, Formosa, China, British New Guinea.

According to Parker (Ind. For. 56: 341, 1930) this species occurs only as a cultivated plant in India. But Bor (Fl. Assam) says "It seems to be wild in Assam". I have also found it growing under truly wild conditions in Travancore along the Western Ghats and in the Terai region in Bengal (Ind. Journ. Genet. and Pl. Breed. 9: 47-58, 1949).

26. *ERIANTHUS RAVENNAE* (L.) Beauv., Ess. Agrost. 14, 162, 177, 1812; Kunth, Enum. Pl. 1: 479, 1833; Suppl. 389, 1835; Hack. in DC. Monog. Phan. 6: 139, 1889; Reichb. Ic. Fl. Germ. t. 55, 1834; Boiss. Fl. Orient. 5: 455, 1884; Duthie Grasses N.W. Ind. 15: Hook. Fl. Brit. Ind. 7: 121, 1896; Hole, Ind. For. Mem. Bot. I, Pl. 1, 87-91, t. 8 and 27, 1911; Silveus, Texas Grasses, 705, 1933; Hitchcock, Man. Grasses U. S. 723, 1935. *Erianthus jamaicensis* Anderss. Ofvers. Svensk. Vet. Akad. Forh. 12: 163, 1855. *Saccharum Ravennae* (L.) Murray, Syst., ed. 13, 88, 1774; Steudel, Syn. Pl. Glum. 1: 408, 1855; Haines, Botany Behar and Orissa, 5: 1014, 1924. *Saccharum Jamaicense* Trin. Mem. Acad. Petersb. Ser. 6, 2: 312, 1833. *Andropogon Ravennae* L. Sp. pl. ed. 2, 1481, 1763. *Ripidium Ravennae* Trin. Fund. Agrost. 169, 1820. *Erianthus purpurascens* Anderss. Ofvers. Vet. Akad. Forh. 12: 161, 1855. *E. scriptorius* Bub. Fl. Pyren. 4: 252, 1901.

An erect grass forming well-defined tufts. *Culms* biennial, mature basal portion of one year old culm not more than 5 cm. long; flowering culms about 6 m. tall, 18 mm. in diameter. *Lamina* 1.2–1.8 m. long, 25–30 mm. broad; sheaths hirsute. *Panicle* 30–90 cm. long; axis glabrous, branches spreading. *Spikelets* 3.5–6 mm. long; pedicels about 2 mm. long; rhachis joints about 3 mm.; callus hairs shorter than spikelets, purplish or brownish; glumes I and II dorsally villous; awn 5–6 mm. long, exerted; palea glabrous.

Hackel differentiated the Mediterranean form as var. *genuinus*, the Indian form as var. *purpurascens* and the Jamaican form as var. *Jamaicensis* on the basis of differences in spikelet length and coloration. But I find variation in spikelet length from 3.5–6 mm. even in the Indian forms and do not find any distinctive features for differentiation of the varieties.

Erianthus Ravennae differs from *S. Griffithii* (Hack.) Hook. f. in a number of characters, particularly the densely flowered inflorescence in which the awn is very short and glumes I and II of the pedicelled spikelet are densely villous on the back. Also the rhachis joint and pedicel are much more densely villous with long hairs. I have therefore recognized *E. Griffithii* (Hack.) Hook. f. as distinct from *E. Ravennae* (L.) Beauv.

Type—based on *Andropogon Ravennae* L.

Sheets examined—INDIA: N. W. HIMALAYA: Hazara, Kazan Valley (12,000 ft.), 18.8.96, Inayat 20323 and 20324; Jirah Expedition: N. W. Frontier, Shinaori (3–4000 ft.), 23–10–97, Inayat 20948; Chamba, Cheri to Kilar (8000 ft.), 4.9.96, J. H. Lace 1489 (CAL); Rawalpindi (1000 ft.), Oct. 1928, R. R. Stewart 10113 (NY). KASHMIR: Gurais Valley (8000 ft.), 6.9.93, J. F. Duthie 13992; Chitral Expedition 1895, Drash (4–5000 ft.), Hamilton 17931; Chitral Relief Expedition 1895, Guirat (4500 ft.), 8–6–95, Harris 16785; Jhelum Valley (2000 ft.), 7 Oct. C. B. Clarke; Punjab, Trop. Region, T. Thomson; Delhi, 22–10–74, C. B. Clarke 23303G Lahore, Dr. Brandis 2988 (labeled “*Erianthus Griffithii*”, Sibpur, but should go under *E. Ravennae*). BALUCHISTAN: Perbat, 5.2.1914, Hb. R.E.P. 18603; Khorasan, 1.9.85, J. E. T. Aitchison 816 (native name in Baluchistan “Kash”). AFGHANISTAN: Kandur, “Munj”; in stream beds, along with *Tamarix* common—a type different from others in having very long inflorescence (about 2 ft.) with long secondary branches. FRANCE: aigues—Mortes, Card. Collections pour Echanges de Mm. Mouillefarine, Salzmann; Avignon ex Hb. Hookerianum aigeus-mortes, Huguenin 185. ANTELLES: Flore Martin, No. 22, June, 1822, Sieber (CAL). GREECE: Orphanides, No. 1282. U.S.S.R.: Cumanum Desert, 14.8.1927, (a very dwarf form with narrow leaves); Transcaucasia, Azerbaidzhan, Lenkoran dist., 22.10.1936 (NY).

Distribution—Mediterranean; Ind. Or.; Jamaica. Cultivated for ornament, native of Asia, introduced in Europe and America.

It is widely distributed from India to the Mediterranean region and southern Europe. A very variable species, the variety *purpurascens* representing a distinct type with pink panicles.

Var. *PURPURASCENS* (Anderss.) Hack. in DC. Monog. Phan. 6: 140, 1889. *E. purpurascens* Anderss. Svensk. Vet. Akad. Ofvers. Forh. 12: 161, 1855.

27. *ERIANTHUS PARVIFLORUS* Pilger in Engl. Bot. Jahrb. 54 (Beibl. 120) 63, 1917.

Culm and leaves not seen. *Panicle* contracted; lanceolate (when fruiting), dense, waxy white, 50 cm. long; sec. branches at base about 20 cm. long; axis glabrous. *Spikelets* narrow, 3.25–3.5 mm.; callus hairs longer than spikelets; rhachis joint and pedicels 1.75–2.25 mm. long; glume I shortly bidentate, hirt-scabrous; glume II hirt-scabrous; awn 2–3.5 mm. long, slightly exerted; palea narrow, short, bidentate.

I could not secure specimens and therefore translated Pilger's description. He suggested its affinity with *E. Ravennae* from which it differs in smaller panicles with longer secondary branches, glumes I and II without any long hairs at back; shorter, almost included awn and callus hairs twice as long as the spikelets.

Type—Amgid, Central Sahara, 16 February 1914, von Schweppen-burg 45, (Also seen at Tahart, Ideles, etc.).

Distribution—Africa: Sahara.

28. *ERIANTHUS MUNJA* (Roxb.) Jesw. Arch. Suikerind. Nederl. Indie (Meded.): 33, 399, 1925. *Saccharum Munja* Roxb. Fl. Ind. ed. Carey 1: 250, 1820; Hole, Ind. For. Mem. Bot. Ser. 1: 62, t. 3, fig. 1 and 19–21, 1911; Troup, Silviculture Ind. Trees, 2, fig. 169, 1921. *Saccharum Sara* Roxb. Fl. Ind. ed. Carey 1: 249, 1820; Duthie, Illustr. Fodder Grasses, t. 51, 1887. *S. Moonja* Royle, Illustr. Himal. Pl. 416, 1839. *Erianthus Sara* (Roxb.) Rumke in Arch. Suikerind. Nederl. Ind. (Meded.): 223, 1934. *Erianthus ciliaris* (Anderss.) Jesw. in Arch. Suikerind. Nederl. Ind. (Meded.): 399, 1925. *Saccharum ciliare* Anderss. Ofv. Svensk. Vet. Akad. Forh. 12: 155, 1855; Illustr. Fodder Grasses, t. 16, 1886; Hack. in DC. Monog. Phan. 6: 118, 1889 (var. *genuinum*) (fig. 4).

In compact clumps. *Culms* biennial; mature basal portion of one-year old culm not more than 5 cm. long. Flowering culms 3.5–5 m. tall, and 1.2 cm. thick, pithy, polished; growth ring inconspicuous, not swollen; root zone about 6 cm. wide, with one row of inconspicuous root eyes; buds small. Leaf sheath about 30–46 cm. long, hairy at base around node and lightly along margins; *lamina* 1.2–2.1 m. long and 0.6–1.2 cm. wide, fulvous along midrib above ligule, unreduced at base; ligule arcuate—crescentiform. *Panicle* 30–75 cm. long, with culm glabrous below the panicle, copiously branching with secondary branches at base 20–24 cm. long and further shorter tertiary and quaternary branches; rhachis joints 4–6 mm. long. *Spikelets* with pedicels about 4–6 mm. long. *Pedicelled spikelet*—gl. I and gl. II coriaceous, dorsally villous with long hairs; gl. III membranous, narrower than II, ciliate along margins; gl. IV about 3 mm. long with 1 mm. long awn and ciliate margin; palea membranous, ovate, ciliate; *lodicules* 2, glabrous, emarginate; stamens 3; ovary glabrous with 2 feathery styles. *Sessile spikelet* similar to pedicelled but with glume II without any hairs at back and gl. I less hairy.

Hooker (Fl. Brit. Ind. 7: 119, 1896) included *Saccharum Munja*, *S. Sara*, and *S. ciliare* under *S. arundinaceum*, but Hole (l.c., 1911) kept *S. Munja* separate, with *S. Sara* and *S. ciliare* as synonyms of it. Haines Bot. Bihar and Orissa 1013, 1924 also separated *S. Munja* from *S. arundinaceum*, following Stapf. I agree with them in keeping *S. Munja* (named here, *Erianthus Munja*, following Jeswiet) as a

distinct species because its vegetative characters are quite different from those of *E. arundinaceus* as are some characters in the inflorescence. *E. Munja* possesses flowering culms only, the lamina is much narrower, never more than 1.2 cm. wide, and the panicle is narrow and thyrsoïd. The rachis joint and the pedicel are shorter than those of *S. arundi-*



FIG. 4.—Photograph of *Erianthus Munja* (Roxb.) Jesw.

naceum; making the inflorescence more compact and densely flowered. I do not agree with Rumke (1934) in calling this species *E. Sara*, which in his opinion has priority over *E. Munja* because *S. Sara* appears on page 249 in Roxburgh's *Flora Indica*, while *S. Munja* is on page 250. Priority of page is not priority in time since the two pages are of the

same date. I accept Hole's arguments in maintaining the name as *Munja*, by which is it known to people of North India.

Type—Roxburgh's drawings of *Saccharum Munja*.

Sheets examined—INDIA: N. W. HIMALAYA: Kangra, Schunto (3000 ft.), 16.10.1874, Clarke 23629B; Chamba (4000 ft.), 8.10.1899 J. H. Lace 2084; Wall. Cat. 8853B. PUNJAB: Multan, Oct. 1891, Munro 33 "vern. Munj-Sar"; 1818 Dr. E. Sanders; Lahore, Oct. 1875, Clarke 27381 (CAL). U.P.: Saharanpur, Oct. 1890, Duthie ex Herb. GANGETIC PLAIN: T. Thomson (S. Sara). S. Tracy ("S. ciliare") (NY). BENGAL: Hughly, Jahanabad, 10.3.1902, Nusker 15 ("S. Sara"); Manbhum, Pukhuria, Rev. Campbell (S. Sara, Vern. Sarghas in Santhali). ANDAMANS: Port Blair, Haddo, 21.10.1915, Parkinson 812. CHINA: Hupeh, 1885-1888, Dr. Henry's collection No. 4227; *S. Ciliare* ex. Hb. S. Kurz (CAL). WEST INDIES: Tobago, Scarborough, 1.9.1913, W. E. Broadway 4681, "cultivated as an ornamental plant" (NY).

Flowering—Oct.-December.

Distribution—India—mainly in Punjab, U.P., Bengal, and Orissa; Andamans; China.

SPECIES DUBIAE

1. *ERIANTHUS FLAVESCENS* K. Schum. in Engl. Pflanzenw. Ost-Afr. C: 96, 1895; Stapf in Prain, Fl. Trop. Afr. 9: 91, 1917.

Type—Stuhlmann No. 3694 from Bukoba, Mozambique, Trop. E. Africa.

Since I was unable to study any material, I followed Stapf in regarding this as an "imperfectly known species".

2. *ERIANTHUS FORMOSANUS* Stapf, Kew Bull. 228, 1898.

This species may belong to *Eulalia*, as Stapf remarks in the original description that it is allied to *Erianthus fastigiatus* Nees, from which it differs in smaller spikelets, ciliate glume IV and with two distinct stamens. Since I could not examine specimens of this species, I am including it as a species dubia.

3. *ERIANTHUS MOUSTIERII* Carr. Rev. Horticulture 35, 1872.

This species is based on a beautiful grass collected by Moustier on Mount Olympus during his voyage to Asia Minor in 1861, and cultivated in his garden. The original description suggests that it is similar to *Gynerium*. Since no details of the spikelets and inflorescence are given in the descriptions and no specimen could be secured by me, I am including it as a doubtful species.

4. *ERIANTHUS POLLINIOIDES* Rendle, Journ. Linn. Soc. Bot. 36: 350, 1904.

The general appearance of this species is different from that of an *Erianthus*. Because of the fascicled branches of the inflorescence and the very narrow linear leaves, it should perhaps, be transferred to *Eulalia*.

Sheets examined—TAIWAN (Formosa): Sirin, Taikoku, T. Tanaka and Y. Shimada, 16 Nov. 1933, Flora of Taiwan, Herb. No. 17874 (NY).

5. *E. SIKKIMENSIS* Hook. f. Fl. Brit. Ind. 7: 123, 1896.

Type—J. D. Hooker's specimen from Lachen Valley (at 6000 ft) in Sikkim, Himalaya, India.

Hooker notes the "specimens very imperfect". Since no specimen of this species is available among the Indian collections it appears to be a doubtful species and may perhaps be a variable form of the allied species.

6. *ERIANTHUS VIOLACENS* K. Schum. in Engl. Pflanzenw. Ost.-Afr. C: 96, 1895; Stapf in Prain, Fl. Trop. Afr. 9: 91, 1917.

Type—Stuhlmann's specimen No. 933 from Itolio, western shore of Lake Victoria, Trop. E. Africa.

Stapf regards it as an "imperfectly known species". Schumann says that *E. flavescens* and *E. violaceus* can only be compared with *E. Sorghum* which is a *Miscanthidium* (*M. Sorghum* Stapf). There is nothing in the description to throw any light on the affinity of these two species". Until Stuhlmann's specimens have been studied these must remain as species dubiae.

NOMINA NUDA

1. *E. JACQUEMONTII* Munro ex Duthie in Atkins. Gaz. N.W.P., India, Himalayan Dist. 1: 636.

The only information given is that the plant is 3–4 ft. tall and collected from Ramganga River, above Kota, in the open at 2500–5500 ft. (Hb. Strachey and Winterbottom No. 3).

2. *E. VELUTINUS* Munro ex Duthie in Atkins. Gaz. N.W.P., 1: 636.

Plants 3 ft. tall, collected from Almora near Jalat, in the open at 5000–6000 ft. (Pollinia No. 1 in Herb. Strachey and Winter-bottom).

SUMMARY

The genus *Erianthus* was established by Michaux in Flora Boreali Americana in 1803. Hackel (1889) revised it in De Candolle's Monographiae Phanerogamarum and recognized 19 species as valid. It is closely allied to *Saccharum* which contains important economic plants, the sugarcane. Taxonomists differ regarding the position of the genus and particularly that of some plants which look very much like sugarcane in external appearance. Should these plants be placed under *Saccharum* or *Erianthus*? Due to the importance of these genera and their confusing position, the author recently revised the genera *Saccharum* (Mukherjee, 1954) and *Erianthus* after examining specimens from the herbaria of New York Botanical Garden and Indian Botanic Garden, and living plants at their natural habitat in India (Mukherjee, 1949).

It was found that the genus *Erianthus* contains 28 valid species, 6 species dubiae and 2 nomina nuda. They differ from *Saccharum* mainly in the non-surgate pith, polished internodes without much waxy secretion, narrow growth ring, narrow root-zone with one row of root eyes (which are sometimes very poorly developed); in the leaves having a narrow arcuate ligule (without any auricle or dewlap) and having dense long hairs along the midrib above ligule; in some floral characters, the most important of which is the presence of an awn on glume IV and of long dorsal hairs on glumes I and II (Fig. 1).

Most species are found in India and America, but a few occur in Africa, Madagascar, the Mediterranean Region, and Polynesia. Full descriptions of the species with critical notes and a key for their identification are given in the paper. *Erianthus elegans* (Jesw.) Rumke

appears as a new combination under *E. procerus* var. *elegans* (Jesw.) Mukherjee.

ACKNOWLEDGMENT

I acknowledge with thanks the kind help of the Head of the Unesco Science Co-operation Office of South Asia in securing the whole collection of American species of *Erianthus* and allied genera from the Herbarium of the New York Botanical Garden, without which the work could not be taken up. A good number of literature references and photostat copies of original descriptions of the species were also secured. Thanks are also due to the Superintendent, Indian Botanical Garden for allowing me to work out the Indian species in the Herbarium and to use the Library. Prof. P. Maheshwari, Head of the Department of Botany, Delhi University, offered facilities and encouragement to do the work, while I was employed there.

I am deeply indebted to Dr. Agnes Chase of the Smithsonian Institution for offering valuable comments and criticism after reading the manuscript. I would also like to offer my heartfelt thanks to Dr. David D. Keck, Head Curator of the New York Botanical Garden, for lending specimens. Thanks are also due the late Dr. E. D. Merrill of Harvard University and Mr. J. H. Kern, Botanist at Herbarium Bogoriense, Indonesia for sending me copies of rare literature references.

LIST OF SYNONYMS*

1. *Andropogon alopecuroides* L. Sp. Pl. 1045, 1753 = *E. alopecuroides* (L.) Ell. (p. 165).
2. *A. divaricatus* L. Sp. Pl. 1045 = *E. alopecuroides* (L.) Ell. (p. 165).
3. *A. durus* Steud. Nom. Bot. ed. 1, 1: 91, 1840 = *E. strictus* Baldw. (p. 168).
4. *A. erianthus* Link, Hort. Berol. 1: 243, 1827 = *E. saccharoides* Michx. (p. 168).
5. *A. Ravennae* L. Sp. Pl. ed. 2, 1481 (1763) = *E. ravennae* (L.) Beauv. (p. 178).
6. *A. strictus* Host, Icon. Gram. Austr. 2(2): t. 2, 1802 = *E. Hostii* Griseb. (p. 169).
7. *Anthoxanthum giganteum* Walt. Fl. Carol. 65, 1788 = *E. giganteus* (Walt.) Muhl. (p. 164).
8. *Calamagrostis rubra* Bosc. ex. Kunth, Enum. Pl. 1: 478 = *E. brevis barbis* Michx. (p. 170).
9. *Erianthus angustifolius* Nees, Agrost. Bras. 316, 1829 = *E. saccharoides* Michx. (p. 168).
10. *E. brasiliensis* (Trin.) Anderss. Ofv. Svensk. Vet. Akad. Forh. 12: 162, 1855 = *E. asper* Nees. (p. 167).
11. *E. capensis* Nees, Fl. Afr. Austr. 93, 1841 = *Miscanthidium Capense* (Nees) Stapf.
12. *E. chrysothrix* Hack. Oest. Bot. Zeitschr. 41: 6, 1891 = *Narenga fallax* (Balansa) Bor.
13. *E. ciliaris* (Anderss.) Jesw. Arch. Suikerind. Nederl. Indie (Meded). 33: 399, 1925 = *E. Munja* (Roxb.) Jesw. (p. 180).
14. *E. Compactus* Nash, Bull. Torr. Bot. Club 22: 419, 1895 = *E. giganteus* (Walt.) Muhl. (p. 164).
15. *E. cuspidatus* Anderss. l.c. 162, 1855 = *E. asper* Nees (p. 167).
16. *E. decus-sylvae* Ridl. ex. Journ. Malayan Branch, Roy. As. Soc. 1: 110, 1923 = *E. Beccarii* (Stapf) Jansen. (p. 174).
17. *E. divaricatus* Hitchc. Contr. U. S. Nat. Herb. 12: 125, 1908 = *E. alopecuroides* (L.) Ell. (p. 165).
18. *E. elegans* (Jesw.) Rumke Arch. Suikerind. Nederl. Indie (Meded). 2: 229, 1934 = *E. procerus* (Roxb.) Raizada, var. *elegans* (Jesw.) Mukherjee (p. 176).
19. *E. fallax* (Balansa) Ohwi, Bull. Tokyo Sci. Mus. 18: 2, 1947 = *Narenga fallax* (Balansa) Bor.

*Page given in parentheses refers to text of this revision.

20. *E. fastigiatus* Nees ex Steud. Syn. Pl. Glum. 1: 409, 1855 = *Eulalia fastigiata* Stapf ex Heyne.
21. *E. Fischerianus* Rupr. ex Doell in Mart. Fl. Bras. 2(3): 258, 1883 = *E. saccharoides* Michx. (p. 168).
22. *E. fulvus* Nees ex Steud. in DC. Monog. Phan. 6: 147, 1889 = *E. rufipilus* (Steud.) Griseb. (p. 162).
23. *E. jamaicensis* Anderss. Ofv. Svensk. Vet. Akad. Forh. 12: 163 (1855) = *E. Ravennae* (L.) Beauv. (p. 178).
24. *E. junceus* Stapf in Dyer, Fl. Cap. 7: 324 = *Miscanthidium junceum*.
25. *E. longifolius* A. Camus in Flor. Gen. Indoch. 7: 246, 1922 = *Narenga fallax* (Balansa) Bor.
26. *E. mishmeensis* Munro ex Hook. f. Fl. Brit. Ind. 7: 124, 1896 = *E. longisetosus* Anderss. (p. 173).
27. *E. Nepalensis* Steud. Nom. Bot. ed. 2, 1: 567, 1840 = *Miscanthus nepalensis* Hack.
28. *E. orientalis* C. Koch, Linnaea 19: 5, 1847 = *E. Hostii* Griseb. (p. 169).
29. *E. pallens* Hack. in DC. Monog. Phan. 6: 145, 1889 = *E. filifolius* Nees ex Steud. var. *pallens* Hook. f. (p. 172).
30. *E. pedicellaris* (Trin.) Hack. in DC. Monog. Phan. 6: 137, 1889 = *E. maximus* Bregm. (p. 176).
31. *E. purpurascens* Anderss. Ofv. Svensk. Vet. Akad. Forh. 12: 161, 1855 = *E. ravennae* (L.) Beauv. (p. 178).
32. *E. saccharoides* var. *Trinii* Hack. in Mart. & Eichl. Fl. Bras. 2: 258, 1883 = *E. trinii* Hack. (p. 165).
33. *E. Sara* (Roxb.) Rumke Arch. Suikerind. Nederl. Indie 2: 223, 1934 = *E. Munja* (Roxb.) Jesw. (p. 180).
34. *E. scriptorius* Bub. Fl. Pyren. 4: 252, 1901 = *E. ravennae* (L.) Beauv. (p. 178).
35. *E. sesquimetricus* Ohwi, Bot. Mag. Tokyo 56: 9, 1942 = *Eulalia fastigiata* Stapf.
36. *E. Smallii* Nash, Bull. N. Y. Bot. Gard. 1: 429, 1900 = *E. contortus* Baldw. (p. 170).
37. *E. Serghum* Nees, Fl. Afr. Austr. 92 = *Miscanthidium Sorghum* (Nees) Stapf.
38. *E. strictus* Bluff. et Fingerh. Comp. Fl. Germ. 1: 105, 1836 = *E. Hostii* Griseb. (p. 169).
39. *E. sumatranus* Henrard in Fedde, Rept. Sp. Nov. 22: 349, 1926 = *E. Beccarii* (Stapf.) Jansen, (p. 174).
40. *E. teretifolius* Stapf, Journ. Linn. Soc. Bot. 37: 478, 1906 = *Miscanthidium teretifolium* Stapf.
41. *E. versicolor* Nees ex Steud. Syn. Pl. Glum. 1: 409, 1855 = *E. filifolius* Nees ex Steud. (p. 172).
42. *Pollinia dura* Trin. Mem. Acad. Petersb. 4: 91, 1836 = *E. strictus* Baldw. (p. 168).
43. *P. longisetosus* Benth. Jour. Linn. Soc. Bot. 19: 67, 1881 = *E. longisetosus* Anderss. ex Benth.
44. *Ripidium Ravennae* Trin. Fund. Agrost. 169, 1820 = *E. ravennae* (L.) Beauv. (p. 178).
45. *Ripidium strictum* Trin. Fund. 169, 1820 = *E. Hostii* Griseb. (p. 169).
46. *Saccharum adpressum* Kit. ex Reichb. Fl. Germ. Excurs. 34, 1830 = *E. Hostii* Griseb. (p. 169).
47. *Saccharum alopecurus* Nees in Hook. Journ. Bot. Kew. Misc. 2: 100, 1850 = *Imperata* sp.
48. *S. alopecuroideum* Nutt. Gen. Pl. 1: 60, 1818 = *E. alopecuroides* (L.) Ell. (p. 165).
49. *S. augustifolium* (Nees) Trin. Mem. Acad. Petersb. 4: 92, 1836 = *E. saccharoides* Michx. (p. 168).
50. *S. arundinaceum* Retz. Obs. Bot. 4: 14, 1786 = *E. arundinaceus* (Retz.) Jesw. (p. 177).
51. *S. asperum* Steud. Syn. Pl. Glum. 1: 407, 1855 = *E. asper* Nees. (p. 167).
52. *S. Baldwini* Spreng. Syst. Veg. 1: 282, 1825 = *E. strictus* Baldw. (p. 168).
53. *S. benghalense* Retz. Obs. Bot. 5: 16 = *E. procerus* (Roxb.) Raizada (p. 175).
54. *S. brasilianum* Trin. Mem. Acad. Petersb. 2: 311, 1832 = *E. asper* Nees (p. 167).
55. *S. brevibarbe* Pers. Syn. Pl. 1: 103, 1805 = *E. brevibarbis* Michx. (p. 170).
56. *S. ciliare* Anderss. Ofv. Svensk. Vet. Akad. Forh. 155, 1855 = *E. Munja* (Rexb.) Jesw. (p. 180).
57. *S. contortum* Nutt. Gen. Pl. 1: 60, 1818 = *E. contortus* Baldw. (p. 170).

58. *S. erianthoides* Rasp. Ann. Sci. Nat. 5: 308, 1825 = *E. giganteus* (Walt.) Muhl. (p. 164).
59. *S. fallax* Balansa Journ. Bot. Paris 4: 81, 1890 = *Narenga fallax* (Balansa) Bor.
60. *S. fastigiatum* Nees ex Steud. Syn. Pl. Glum. 1: 109, 1855 = *Eulalia fastigiata* Stapf ex Heyne.
61. *S. filifolium* Steud. l.c. 409 = *E. filifolius* Nees ex Steud. (p. 172).
62. *S. giganteum* (Walt.) Pers. Syn. Pl. 1: 103, 1805 = *E. giganteus* (Walt.) Muhl. (p. 164).
63. *S. giganteum* Pers. (misapplied by Trin) Mem. Acad. Petersb. 2: 311, 1832 = *E. Trinii* Hack. (p. 165).
64. *S. Griffithii* Munro ex Aitchis. Journ. Linn. Soc. Bot. 19: 191, 1882 = *E. Griffithii* (Hack.) Hook. f. (p. 171).
65. *S. Jamaicense* Trin. Mem. Acad. Petersb. 2: 312, 1832 = *E. ravennae* (L.) Beauv. (p. 178).
66. *S. longifolium* Munro ex Benth. Journ. Linn. Soc. Bot. 19: 66, 1818 (name only) = *Narenga fallax* (Balansa) Bor.
67. *S. maximum* Trin. Mem. Acad. Petersb. 2(1): 92, 1836 = *E. maximus* Brongn. (p. 176).
68. *S. Moonja* Royle, Illustr. Himal. Pl. 416 = *E. Munja* (Roxb.) Jesw. (p. 180).
69. *S. Munja* Roxb. Hort. Beng. 6, 1814 (name only); Fl. Ind. ed. Carey 1: 250, 1820 = *E. Munja* (Roxb.) Jesw. (p. 180).
70. *S. procerus* Roxb. Fl. Ind. ed. Carey 1: 248 = *E. procerus* (Roxb.) Raizada (p. 175).
71. *S. Ravennae* (L.) Murr. Syst. Veg. ed. 13: 88, 1774 = *E. ravennae* (L.) Beauv. (p. 178).
72. *S. rufipilum* Steud. Syn. Pl. Glum 1: 409, 1855 = *E. rufipilus* (Steud.) Griseb. (p. 162).
73. *S. Sara* Roxb. Hort. Beng. 6, 1814 fl. Ind. ed. Carey 1: 241, 1820 = *E. Munja* (Roxb.) Jesw. (p. 180).
74. *S. strictus* Nutt. Gen. Pl. 1: 60, 1818 = *E. strictus* Baldw. (p. 168).
75. *S. strictum* (Host.) Spreng. Pugill. 2: 16, 1815 = *E. Hostii* Griseb. (p. 169).
76. *S. versicolor* Steud. Syn. Pl. Glum. 1: 409, 1855 = *E. filifolius* Nees ex Steud. (p. 172).
77. *Spodiopogon Beccarii* Stapf. Kew Bull. 228, 1898 = *E. Beccarii* (Stapf.) Jansen, (p. 174).

LITERATURE CITED

- Artschwager, E. 1948. Vegetative characteristics of some wild forms of *Saccharum* and related grasses. U. S. Department of Agriculture, Tech. Bull. No. 951.
- Bentham, G. 1881. Notes on Gramineae. Journ. Linn. Soc., Bot., 19: 66-67.
- Bor, N. L. 1940. Flora Assam, Vol. 5.
- Camus, A. 1922. Gramineae in Lecomtis Flore Generale de L'Indochine, Vol. 7.
- Duthie J. F. 1883. A list of the Grasses of N. W. India.
- Dutt, N. L. and Rao, J. T. 1950. The present taxonomic position of *Saccharum* and its congeners. Proc. Int. Soc. Sug. Tech., VII Congr., Brisbane, 288-293.
- Grassl, C. O. 1946. *Saccharum robustum* and other wild relatives of "noble" sugarcanes. Journ. Arn. Arb. 27: 234-252.
- Hackel, E. 1889. Andropogonae in DC. Monographiae Phanerogamarum.
- Hitchcock, A. S. 1935. Manual of the Grasses of the United States. U. S. Dept. Agr., Misc. Publ. No. 200.
- Hole, R. S. 1911. On some Indian forest grasses and their ecology. Ind. Forest Memoirs, For. Bot. Ser. I, Pt. I, 1-126.
- Hooker, J. D. 1896. Flora British India, 7: 121-126.
- Jeswiet, J. 1925. Beschrijving der soorten van het suikerriet. 'Bijdrage tot de Systematiek van het geslacht *Saccharum*. Arch. Suikerindus. Nederland. Indie, Meded. Proefsta. Java-suikerindus. 33(12): 391-404.
- Michaux, A. 1803. Flora Boreali Americana 1: 54-55.
- Mukherjee, S. K. 1949. Studies in *Saccharum* spontaneum and allied grasses. I. Preliminary Report on Collection. Ind. Journ. Genet. Pl. Breed. 9: 47-58.
- . 1954. Revision of the genus *Saccharum*. Bull. Bot. Soc. Bengal 8: 143-148.
- Roxburgh, W. 1820. Flora Indica, ed. Carey, 1: 239-251.
- Rumke, C. L. 1934. *Saccharum*—*Erianthus* Bastaarden. Arch. Suikerindus. Nederland. Indie, Meded. Proefsta. Java-suikerindus. No. 7, 211-261.
- Steudel, E. G. 1855. Synopsis Plantarum Glumacearum 1: 405-409.

Age and Chemical Constituents of Individuals of the Lichen *Lasallia papulosa*

CHICITA F. CULBERSON AND WILLIAM L. CULBERSON

(Department of Botany, Duke University, Durham, North Carolina)

Increasing attention in lichen taxonomy is being paid to the lichen substances, extra-cellular acetone-soluble compounds peculiar to the lichens (Asahina and Shibata, 1954). Some lichenologists feel that a consideration of these substances is indispensable to the most precise systematic studies and elaborate methods for the identification of the substances have been devised. The use of lichen chemistry in taxonomy implies a constant predictable occurrence of specific substances among individuals of a species or among individuals of the various "chemical strains" of a species. Likewise it has been tacitly assumed—but apparently never demonstrated—that thalli of various ages of a given species or strain all contain the same lichen substances.

The aim of our study is to determine for a single lichen species if differences in chemical content exist among thalli of different age. Since direct determination of the age of individuals is impossible, surface area and weight might be used to measure age on the assumption that both increase as age increases.

The foliose rock-inhabiting *Lasallia papulosa* (Ach.) Llano, the "Umbilicaria pustulata" of the older American literature, was selected for study. Many thalli of all sizes were collected in 1956 from a single boulder near the summit of Mt. Mitchell (elev. 6,684 ft.), Yancey County, North Carolina. A voucher specimen (W.L.C., No. 6775) is in Duke Herbarium.

We thank Professor Aubrey W. Naylor who furnished the Welsh Desichron used in this study.

THALLUS SURFACE AREA AND THALLUS WEIGHT

The specimens were moistened with distilled water, pressed, dried, examined under the dissecting microscope, and cleaned of debris. The presence of apothecia was noted. All obviously broken thalli were discarded. After subjection to a constant atmosphere (relative humidity of 35 percent at 23°C) for two weeks, the thalli were weighed with an analytical balance.

The thalli were placed on sheets of photographic (kodabromide) paper, covered with a pane of glass, and exposed. The silhouettes produced were used to determine area. Areas greater than one cm.² could be measured accurately with a planimeter. But smaller thallus areas were determined by cutting out and weighing tracings of the silhouettes on paper for which the weight per unit area had been determined. For thallus areas over one cm.² the method of weighing gave excellent agreement with areal determinations by planimeter for the same thalli. Weight among the 138 individuals in the study ranges from 0.0010 to 0.2948 g. Of course, if plants of different weight absorb water in greatly different percentages, then the weights recorded would not be directly proportional to the dry weight the very determination of which might effect the results of the chemical study. Therefore small samples of material from the various size classes were dried at 110°C for 44.5 hours. All contained about 12 percent water

and the previously determined weights were assumed to be comparable. The heat-treated samples were rejected from further use.

The 138 plants were placed in size classes based on weight. The number of individuals in the classes, from smallest to largest, is 5, 31, 26, 20, 20, 15, 9, 5, 5 and 2 respectively.

Fig. 1 shows the relationship between average weight and average area of the specimens of the 10 size classes. The sharp increase in weight *vs.* area in the middle classes (5-8) is clarified by consideration of the curve for the percentage of the fertile thalli. The formation and development of the dense apothecia, which do not contribute to surface area as measured here, account for the increase in weight between classes 5 and 8, classes obviously containing the maturest plants. In the classes of the largest plants, weight does not increase so rapidly perhaps because old plants tend to become somewhat perforate. Although neither measure offers a perfect determination of age, weight seems to be more accurate than surface area and is selected for use here.

THALLUS AGE AND THALLUS CHEMISTRY

The thalli of alternate size classes (classes 2, 4, 6, 8 and 10) were pulverized. In class 2, 0.1 g., the total sample, was extracted but in the other classes 0.3 g. was used. The samples were extracted with acetone for 14-16 hours in a soxhlet. The extracts of each size class were prepared for chromatography by dilution with acetone to 25 ml. On a single sheet of Whatman No. 1 chromatographic paper, 100 λ of solution from classes 4, 6, 8, and 10 and 300 λ of solution from class 2 were applied as spots one cm. in diameter. (Three times as much solution from class 2 was used because it had been prepared from a sample only one-third as large as those for the other classes). The chromatogram was suspended in the tank for 12 hours before being lowered into n-butanol over a layer of concentrated ammonium hydroxide. After development individual chromatograms were cut apart and optical density curves (Fig. 2) for each were obtained by the Welsh Densichron, a chromatographic densitometer.

The peaks below Rf .10 are caused by the original spots themselves and are without significance. The largest peaks, those at about Rf .30 correspond to gyrophoric acid ($C_{24}H_{20}O_{10}$, a depside of three molecules of orsellinic acid). The presence of gyrophoric acid, the most abundant lichen substance in the study material, was also confirmed microchemically (for method, see Culberson and Culberson, 1956). The peaks at about Rf .80 represent an unknown red pigment. The substances responsible for the other peaks are likewise not referable to known compounds.

The curves reveal no trends or constant differences among the extracts of the various size classes of the thalli of *L. papulosa*. Likewise, a number of similarly prepared chromatograms, sprayed with a 1 percent alcoholic solution of ferric chloride, appeared to be qualitatively identical. Sprayed chromatograms are, however, unsuitable for studies with the Welsh Densichron.

DISCUSSION

It should be remembered that the individuals in our study all grew within a small area of doubtless uniform environment. There is information to indicate that lichen substances may vary quantitatively

among individuals of a species from different habitats. For example, infraspecific taxa have been described for pale-colored individuals of normally yellow, usnic acid-containing species. These pale-colored

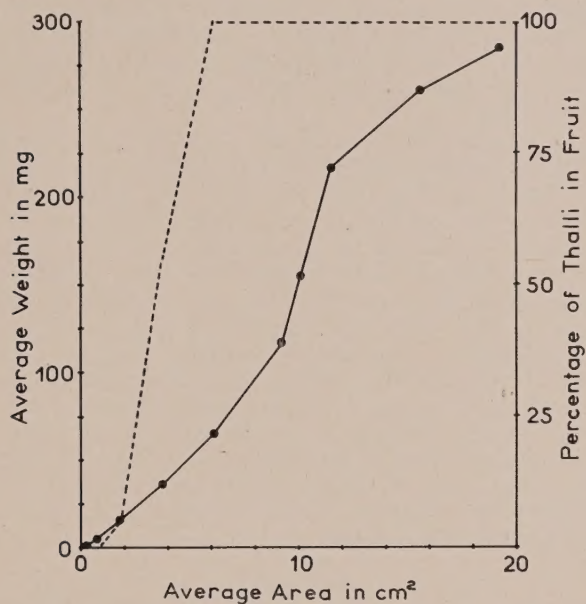


FIG. 1. The average weight in mg. (—) and the percentage of fertile thalli (---) for each size class as compared to the average surface area in cm.²

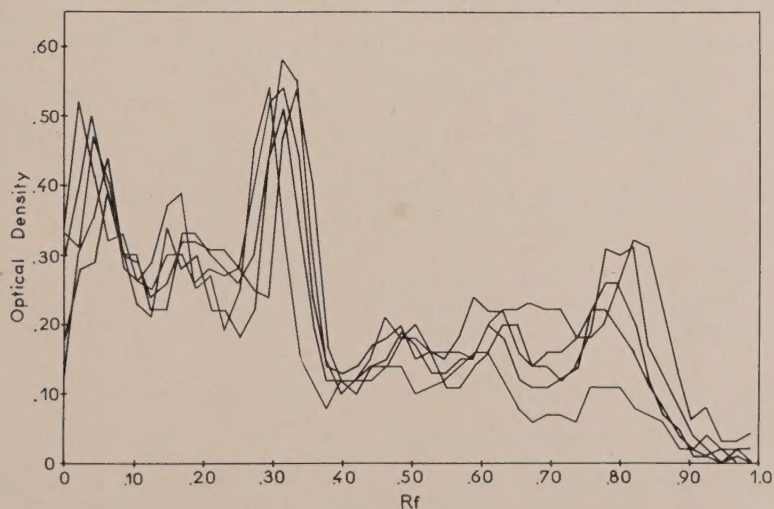


FIG. 2. Graphs of the optical density along the chromatogram of extracts of the 5 size classes analyzed. For details see text.

plants, often of lax growth produced in poorly illuminated habitats, are called "shade forms" (*Schattenformen*) (cf., Tobler, 1925, p. 145) and presumably contain less usnic acid than their counterparts growing in full sun. Other data come from microbiological studies. Tests of the antifungal activity of thalli of lichens of one species from different substrates show significant variations. The differences are attributed to variations in the amount of the active principles (lichen substances) produced in thalli growing under different substrate conditions (Tichý and Rypáček, 1954).

We do not suggest that no chemical changes whatsoever accompany ageing in lichens growing under uniform conditions. Indeed it would be most surprising if there were not chemical changes of some sort considering the great number of compounds (only a few of which are "lichen substances") that make up the plants. But if changes among the extracellular acetone-soluble constituents (the "lichen substances") of *L. papulosa* occur with age, they are not detectable by our analysis. The changes, if such exist, are subtle and quantitative rather than gross and qualitative. The use of chemistry in lichen taxonomy is now restricted to consideration of the qualitative distribution of lichen substances among individuals, species, and genera. If, as our data show for one species, the ability of variously aged individuals of a species to produce the same substances is widespread among lichens (and there is no reason to believe otherwise), then lichen substances merit recognition as taxonomic characters equivalent to that accorded to major morphologic characters.

SUMMARY

Although some recent studies in lichen taxonomy attribute much importance to the chemical content of species, there have been apparently no previous investigations of possible variation in lichen substances in thalli differing in age. The relationship between weight and surface area of thalli of the North American lichen *L. papulosa* (Ach.) Llano is examined. Weight is accepted as the better measure of age because it is influenced by fruit production in the obviously more mature plants whereas surface area, as measured here, is not. A chromatographic study of the acetone-soluble chemical constituents (the "lichen substances") of individuals of different age shows no variations detectable with the Welsh Densichron. The depside gyrophoric acid is the most abundant lichen substance in all individuals, but the chromatographic analysis indicates that other lichen substances, as yet unidentified, are of qualitatively equal distribution among thalli of all ages. The lichen substances of *L. papulosa* present a qualitatively constant characteristic of the species and are therefore of primary taxonomic significance.

LITERATURE CITED

- Asahina, Y. and S. Shibata. 1954. Chemistry of Lichen Substances. 240 pp. Tokyo.
- Culberson, W. L. and Chicita F. Culberson. 1956. The systematics of the *Parmelia dubia* group in North America. Amer. Jour. Bot. 43: 678-687.
- Tichý, V. and V. Rypáček. 1954. Vliv stanovište na fungistické schopnosti lišejníků. [The influence of the habitat on the fungistatic activity of the lichens.] Spisy Vydávané Přírodovědeckou Fakultou Masarykovy Univ. [Brno] K9(346): 101-118.
- Tobler, F. 1925. Biologie der Flechten. 265 pp. Berlin.